SCIENCE ABSTRACTS.

PHYSICS AND ELECTRICAL ENGINEERING.

JULY 1900.

GENERAL PHYSICS.

1392. *Bending Modulus of Beeswax and Paraffin.* **M. S. Segel.** (Phys. Zeitschr. 1. pp. 126–127, 1899. Communicated by the Physikalischen Institute der Universität Kasan.)—Interference bands are used in measuring the bending of short beams of the substances. The plastic effect is very large, and Young's Modulus, calculated from the elastic effect is found to vary from 223·4 kg/mm^2 at 5° to 127·4 kg/mm^2 at 23° in paraffin, and from 59·1 kg/mm^2 at 11·5° to 46·6 kg/mm^2 at 19·4° in wax. G. E. A.

1393. *Hoop Stresses and Tensile Strength.* **M. Grübler.** (Phys. Zeitschr. 1. pp. 190–191, Jan. 20, 1900. Report read before the 71st. Naturforscherversammlung in Munich.)—In testing hollow cylinders of white sandstone to destruction by rotation at high speeds, the hoop stress was on the average 51·5 kg. per sq. cm. With this material the modulus of elasticity is practically constant up to the breaking point. Careful tensile tests on the same material gave a strength of 21·6 kg. per sq. cm. The great discrepancy between these two results is, in the opinion of the author, due to imperfections in loading the tensile test specimens uniformly. The theory of the stresses in a rotating disc shows that if a small hole be drilled at the centre of the disc, the stress is double that in a complete disc rotating at the same speed; wherefore the bursting speed of rotation of the complete disc should be $\sqrt{2}$ times that of the perforated disc. Tests of hollow cylinders and solid cylinders of white sandstone, however, showed that they burst at practically the same speeds. A. S.

1394. *Calibration of a Glass Tube and Compressibility Coefficients.* **G. A. Hulett.** (Zeitschr. Phys. Chem. 33. pp. 237–244, April 17, 1900.)—The author's method of calibration, which is quicker than, and obviates the troublesome calculation required by, the ordinary method, is as follows: The tube is filled to the zero point of the scale with mercury, which is then kept in a fixed position by closing the lower end of the tube. By means of a narrow capillary pipette successive equal volumes of mercury are removed, the various positions of the meniscus being read off. From the number of the reading and the total amount of mercury taken away the corrections for irregularity of the tube are calculated. For internal diameters less than 0·50 mm., the method is difficult to carry out.

Taking Amagat's value, 39×10^{-7}, for the absolute compressibility of mercury for 1 atmosphere, the author finds the following numbers for the compressibility of water saturated with air. At 9°, $45{\cdot}3.10^{-6}$; at 17°, $44{\cdot}6.10^{-6}$; at 50°, $41{\cdot}9.10^{-6}$. For paratoluidine at 45° the value is $51{\cdot}2.10^{-6}$.
T. H. P.

1395. *Thermal Deformation of a Balance.* **T. Middel.** (Ann. d. Physik, 2. 1. pp. 115–134, May, 1900.)—In their determination of the gravitational constant in the citadel of Spandau, Richarz, and Krigar-Menzel observed strong variations of the sensitiveness of their balance. The author shows that these variations were due to the unequal thermal expansion of the parts of the balance beam, some of which were made of rolled brass, while the others were made of cast brass. He tested the beam used by those experimenters, and proved by means of two mirrors attached to the ends and at right angles to the beam that the beam was bent by a rise of temperature, as indicated by an increase in the angle between the two mirrors. The rolled brass has a higher coefficient of expansion than the cast brass. No additional error is introduced by placing the weights on the balance. Moreover, a few oscillations of the temperature suffice to annul the bending. E. E. F.

1396. *Stereoscopic Rangefinder.* **C. Pulfrich.** (Phys. Zeitschr. 1. pp. 98–102; Discussion, pp. 102–104, 1899. Report read before the Naturforscherversammlung in Munich.)—The rangefinder which this paper deals with is the one now made by Zeiss of Jena, the original idea and fundamental design emanating from the late H. de Grousilliers.

The instrument consists essentially of a Helmholtz "Telesterescope," with scales introduced in the two eyepieces. These two scales are so graduated and so arranged that when viewed simultaneously in the eyepieces with the two eyes, the two scales seem to combine and to represent one scale stretching from the observer away to an infinite distance in the landscape. To find the range of any object it remains only to judge which mark on the scale seems to be at the same distance as the object is from the observer.

The accuracies claimed for the different sizes of instrument are as follows:—

Range.	I. Magn. = 8. Base = 50 cm.	II. Magn. = 14. Base = 87 cm.	III. Magn. = 23. Base = 144 cm.
500 m.	9 m.	3 m.	—
1,000 m.	35 m.	12 m.	5 m.
2,000 m.	141 m.	50 m.	18 m.
4,000 m.	564 m.	200 m.	70 m.
8,000 m.	— m.	800 m.	280 m.

J. B. H.

1397. *Water-Bath Regulator.* **H. S. Hatfield.** (Chem. News, 81. p. 65, Feb. 9, 1900.)—The water supply-tube bifurcates, one limb dipping under the water in the bath, whilst the other, by which the excess of water escapes, has an opening in its side at the desired height. The apparatus possesses an advantage over other regulators in that its action is not affected by the collection of air-bubbles, which are immediately carried away by the current of water. N. L.

1398. *A Manostat.* **A. Smits.** (Zeitschr. Phys. Chem. 33. pp. 39–46, April 3, 1900. Paper read before the Koninklijke Akademie van Wetenschappen, Amsterdam, Nov. 27, 1897.)—The results of ebullioscopic experiments are often seriously affected by alterations in the atmospheric pressure during the progress of the work. The author has therefore devised an apparatus (manostat) whereby the pressure is maintained constant to within less than 1 mm. of water. It consists essentially of a manometer connected with an electrical mechanism by means of which the vessel is connected with an exhaust or compression apparatus when the pressure indicated either rises above or falls below a certain value. Diagrams of the apparatus are given in the paper. N. L.

1399. *Minerals and Pseudomorphs from Malfidano (Sardinia).* **F. Millosevich.** (Accad. Lincei, Atti, 9. pp. 153–159, March 4, 1900.)—Crystals of the following minerals from Malfidano mines are described: Cerussite, anglesite, gypsum, cerussite pseudomorphous after anglesite, cerussite after phosgenite, smithsonite after calcite, and smithsonite after anglesite. T. H. P.

1400. *Irreversible Processes.* **S. H. Burbury.** (Phil. Mag. 49. pp. 475–486, May, 1900.)—This paper discusses mathematically Boltzmann's H theorem. The conclusion is drawn that the H theorem does not prove that, in the test system of colliding elastic spheres, the diminution of H is irreversible in the same sense as loss of kinetic energy by friction. The process is, however, held to have a certain physical significance. E. H. B.

1401. *Fundamental Theories of Pressure.* **L. Boltzmann.** (Ann. d. Physik, 1. 4. pp. 673–677, April, 1900.)—Hertzian mechanics always proceed from a definite number of material particles, however large, and never from a real *continuum*. By indefinitely increasing the number of particles, making their density continuously variable from point to point, and allowing each point to retain its density permanently, a well-defined and detailed mental picture of the whole world of physical phenomena may be obtained. The author is, however, not convinced of the utility of such a detailed conception. It involves the introduction of some arbitrary hypotheses which may at any time have to be abandoned. From a philosophical point of view, the conception of an incompressible fluid or a rigid impenetrable body has no advantage over that of atoms acting at a distance. The former is derived in an equally rough manner from the approximate behaviour of liquid and solid bodies, as the latter from that of the heavenly bodies. E. E. F.

1402. *Propagation of a Solitary Wave.* **R. F. Gwyther.** (Manchester Lit. & Phil. Soc., Mem. 44. 9. pp. 1–12, 1900.)—The writer refers to the researches of Russell, Rayleigh, and others on the solitary wave, and points out that the complete solution is difficult owing to the difficulty of satisfying the surface conditions over the whole wave. It is necessary to approximate. The general method adopted is to find a solution with close approximation in some parts of the wave, generally the outskirts, and then to find the degree of approximation attained in other parts. Two terms of approximation corresponding to the two first terms of a series are worked out mathematically, and the results compared with Russell's experiments. Stokes has suggested that the motion is not one capable of being reduced to steady motion, but that a gradual reduction of the altitude of the wave is a necessary part of the phenomenon. The method of the present paper, the author says, is not adapted for the investigation of this question. S. H. B.

1403. *Wave Velocity and Group Velocity.* **H. Lamb.** (Manchester Lit. & Phil. Soc., Mem. 44. 6. pp. 1–5, 1900.)—It was observed by S. Russell that a group of waves has less velocity of propagation than the individual waves composing it. Rayleigh has shown that where V, the velocity of the individual wave (Russell's wave velocity), is a function of λ the wave-length, then U, the velocity of the group, is given by—

$$U = V - \lambda\frac{dV}{d\lambda}$$

Hence Lamb deduces the geometrical representation: If λ be abscissa and V ordinate, and we draw the curve $V = f(\lambda)$, U is the intercept of the tangent on the axis of V. He then mentions three special cases, according as (1) gravity alone acts and V varies as $\sqrt{\lambda}$; or (2) capillarity alone, in which case V varies as $\frac{1}{\sqrt{\lambda}}$; or (3) both gravity and capillarity, in which case V varies as $\sqrt{\frac{\lambda}{a} + \frac{a}{\lambda}}$. This latter case is discussed. The writer also refers to the cases of 4) waves of flexure travelling along an elastic rod where V varies as $\frac{1}{\lambda}$, and (5) waves on a tense string, every point of which is urged towards its equilibrium position with a force varying as the displacement, in which V varies as $\sqrt{a^2 + \lambda^2}$. S. H. B.

1404. *Life of Matter.* **C. E. Guillaume.** (Archives des Sciences, 9. pp. 133–146, Feb., 1900.)—The author specifies certain physical processes which have close analogies in physiology, and may be regarded, in fact, as constituting an elementary form of life in the biological sense. Among the processes so specified are those of fatigue and those of adaptation to impressed forces. An instance of the latter is the hardening of a metal at the constriction which appears at the point of impending rupture. If, before rupture actually takes place, the bar is turned to a uniform diameter, it will, if exposed again to a breaking stress, invariably break at a point different from that at which rupture was about to take place before. An even more striking case of protective modification is presented by the grey iodide or chloride of silver in the Becquerel process of colour photography. The silver salt assumes the colour of the light which impinges upon it, and thus enables itself to reflect it. If it did not do that it would have to absorb the radiation, and the energy so absorbed would have the effect of reducing the silver salt.
E. E. F.

1405. *Spectrum of the Corona.* **J. N. Lockyer.** (Roy. Soc., Proc. 66. pp. 189–192, April 4, 1900.)—This paper contains the results of measurements of the wave-lengths of rings due to the corona, obtained from five of the eight plates exposed during the eclipse of January, 1898, in India. The rings found on the photographs were divided into three groups, determined by the position-angles in which they showed greatest brightness. The typical examples of each class are, λ 5,303·7 (green), λ 3,987 (violet), λ 4,359·5 (blue). A drawing is given showing the different appearance of each of these rings, following which are three tables giving the details of all other coronal lines under their respective types. In all forty-five lines are assigned wave-lengths, The question as to the presence of carbon in the corona is still unsettled, but there is a possible trace of the fluting at λ 4,736·18. Minute examination of the form of the green corona ring shows that it is more intimately associated with the inner corona, in fact it appears to have no distinct connection with the outlying streamers. The outer corona gives no indications of bright line spectra. C. P. B.

1406. *Circulation in the Atmosphere.* **V. Bjerknes.** (Phys. Zeitschr. I. pp. 215–217, Feb. 10, 1900. Report read before the 71 Naturforscherversammlung in Munich. Full paper in Meteorolog. Zeitschr., March & April, 1900, pp. 97–106, 145–156.)—The paper is based upon a generalisation of Kelvin's circulation of a curve. If a series of material points of a continuous fluid with definite velocities form a closed curve, the integral of the tangential components of the velocities is called the circulation of the curve. It is a constant quantity provided the density of the fluid be simply a function of the pressure. In order to discuss the general case without restriction as to density, the author imagines the fluid to be divided by surfaces of equal pressure. These isobaric surfaces will be closed belts all round the earth or cut the earth, but cannot cut one another. The same applies to isosteric surfaces of equal specific volume, which will be at different levels owing to local differences of temperature. The intersections between the two systems of surfaces will be tubes, which he designates solenoids, and any closed curve will enclose a definite number of solenoids. From a consideration of the normals to the two kinds of surfaces, the gradients and the mobilities, the author derives rules concerning rising air currents in warm spots and descending currents in cold spots, showing that the wind must blow from the cold to the warm district on the surface of the earth, and from the warm to the cold districts at higher levels. In this way he accounts for trade winds, land and sea winds, valley and mountain currents, monsoons, and even cyclones. Friction, rotation, and water vapour are not taken into consideration. H. B.

1407. *Thermodynamics of the Atmosphere.* **W. v. Bezold.** (Preuss. Akad. Wiss. Berlin, S. ber. 20. pp. 356–372, April 19, 1900.)—The author discusses the decrease in the atmospheric temperature with the altitude as would result simply from vertical air currents, and makes use of the term "potential temperature," *i.e.*, the temperature which a body assumes when reduced to normal pressure, adiabatically or pseudo-adiabatically. Expansion of air, saturated with humidity, can be truly adiabatic only when any condensed water remains suspended in that bulk of air; otherwise the change is pseudo-adiabatic. The difference hardly affects the formulæ. But it must be considered when an ascending current changes into a descending current, because it is then of importance, whether or not the moisture, condensed during the rising, is still carried by the air. Adiabatic changes of humid air do not alter the potential temperature, pseudo-adiabatic changes raise it; the potential temperature increases with the altitude. At high altitudes the rate of decrease in the temperature should approach 1° C. per 100 m. The Berlin balloon observations confirm this conclusion: between 7,000 and 8,000 m, $-\Delta t = 0{\cdot}72^\circ$; between 8,000 and 9,000 m., $-\Delta t = 0{\cdot}90^\circ$. In the medium and lower strata, convection currents and radiation from the soil complicate the conditions and make temperature reversals much more common than was formerly assumed. But pseudo-adiabatic expansion, with subsequent condensation, raises the temperature of the medium strata of chief cloud formation, so that, eliminating cases of reversal observations, the temperature gradient is only 0·54° between 1,000 and 4,000 m., whilst it is 0·61° between 0 and 1,000 m., and 0·64° between 4,000 and 5,000 m. Radiation of heat from the earth is the chief source of the atmospheric heat, but the losses by radiation overcome the gain so far as the relative temperature in the vertical is concerned. The second part of the paper deals with compound convection currents, cases when moist air, ascending at one spot, descends to another spot, which receives the benefit of the heat absorbed for evaporation at the starting-point. Such convection currents make the zones bordering upon the belt of calms warmer, and their effect upon the climates of various latitudes is discussed with regard, not to equal differences of latitude, as is often done, but to zones of equal area. H. B.

1408. *Propagation of Earthquake Motion.* **R. D. Oldham.** (Roy. Soc., Phil. Trans. 194. pp. 135–174, March 29, 1900; Roy. Soc., Proc. 66. pp. 2–3, Feb., 1900.)—From the examination of some earthquake observations which are considered specially reliable, the author comes to the general conclusion "that in the complete record of a distant earthquake three distinct types of wave motion can be recognised—(1) condensational; and (2) distortional plane waves, travelling by brachistochronic paths through the earth; and (3) elastic, or gravitational elastic, surface waves, travelling round the surface of the earth. The records are, however, often incomplete by the omission of the first, or the first and second, of these phases; and the widely divergent estimates of the apparent rate of propagation of the preliminary tremors are largely due to this." A. G.

REFERENCES.

1409. *Compensation of Relative Gravitational Results.* **A. Venturi.** (N. Cimento, 11. pp. 33–46, Jan., 1900.)—The paper is a mathematical analysis of the probable errors involved in the use of a Sterneck's apparatus (possessing four pendulums) for the determination of the relative values of the accelerations due to gravity. A. G.

1410. *Stellar Radial Velocities.* **H. C. Vogel.** (Preuss. Akad. Wiss. Berlin, S.ber. 20. pp. 373–390, April 19, 1900.)—This paper consists of a review of the progress made in the spectroscopic determination of stellar velocities in the line of sight during the last ten years. C. P. B.

LIGHT.

1411. *Propagation of Light through Absorptive Media.* **Sagnac.** (Soc. Franç. Phys., Bull. 141. pp. 3–4, Jan. 5, 1900.)—The author shows how his kinematic explanation of the transmission of light through matter [see Abstract No. 48 (1900)] may be applied to the case of anomalous dispersion. Account must be taken of the changes of phase which accompany the reflection of vibrations at absorbing particles which resemble resonators. The case of Hertzian resonators shows that the taking in of energy by emission or by transformation into heat has two principal effects :

(1) To each one of the resonators' own periods θ_0 corresponds a band of absorption more marked in proportion, as the damping of its own vibrations due to the external borrowing of energy is more considerable.

(2) The forced vibrations of the resonant system experience an acceleration of phase when their period θ is less than θ_0, a retardation when θ is superior to θ_0, a change of phase of a quarter of a period when θ has the value θ_0.

Hence there results that on the violet side of the absorption band there is an acceleration of the phase of the vibrations reflected by the surface of the absorbing body, and a diminution of the index of refraction ; on the red side of the absorption band a retardation of phase by reflection occurs, and an increase of the index of refraction.

For $\theta = \theta_0$ the changes of phase introduced by absorption cancel each other sensibly for transmitted vibrations, but the change of phase of a quarter of a period affects the reflection at the absorbing body. This last phenomenon, especially frequent in the case of the metals over the extent of the visible spectrum does not occur in the reflection of Hertzian vibrations at a mirror of dimensions much greater than the wave-length, because the material particles are not resonant, and electric induction comes into play in the surface portion of the mass as a whole, and brings into action the electric conductivity ; on the contrary, for visible luminous vibrations, and for metals such as silver, it seems permissible to neglect the phenomenon of electric induction throughout the extent of the superficial layers. J. J. S.

1412. *Determination of Refractive Index.* **E. Cominotto.** (Rivista Sci.-Industriale, 32. pp. 49–50, March 10, 1900.)—A simple method of determining the refractive index of a liquid is the following : It is enclosed in a spherical glass vessel exposed to solar or other parallel rays. The distance f of the focus from the centre of the sphere is measured, as well as the radius r of the sphere. Then the refractive index of the substance is—

$$n = 2f/(2f - r).$$

The author deduces this simple rule from Gauss's theory of thick lenses, and verifies it experimentally. The method also applies to solids obtainable in the form of spheres. E. E. F.

1413. *Refractive Indices of Solutions. III.* **C. Bender.** (Ann. d. Physik, 2. 1. pp. 186–196, May, 1900. [See Abstracts Nos. 1471 (1899) and 35 (1900).]—This part of the work deals with the refractive index of KCl solutions as dependent upon concentration and temperature. The spectrum lines studied were the three lines at H. For $\mu = 1$, or 74·58 gr. in 1 litre at 15°, the formula for Hα is, between 10° and 40°,

$$H\alpha = 1{\cdot}3422598 - 0{\cdot}00026695 \left(\frac{t}{5}\right) - 0{\cdot}000030227 \left(\frac{t}{5}\right)^2$$

As regards the dependence of n upon the concentration μ, we have the formula tor Hα,

$$n = (\text{water}) + 0.0096895\,\mu - 0{\cdot}00025820\,\mu^2$$

for 15° to 70°, and $\mu = 0$ to 3.

The molecular refraction of KCl is calculated from the formula—

$$m\mathrm{R} = \frac{\mathrm{Q}r - q\rho}{\mu}$$

where q is the weight of the solvent in grammes, m the molecular weight of the solute (for KCl 74·58), μ the number of gramme-molecules in solution, Q the weight of the unit of volume in grammes, r the "refraction constant" of the solution, ρ that of the solvent, and R that of the solute. This "refraction constant" may be any one of the following:—

$$\frac{n-1}{d}, \quad \frac{n^2-1}{d}, \quad \frac{n^2-1}{(n^2+1)\,d}, \quad \text{or} \quad \frac{n^2-1}{(n^2+2)\,d}.$$

Taking the last of these, the molecular refraction of KCl comes out at about 11·5. It increases at first slightly with the concentration, and then decreases again. The refractive index of solid KCl for Hα at 15° C. should be 1·5175, as derived from the values for $\mu = 1$. Similarly, the atomic refraction of potassium is 9·60, and its refractive index 1·2137. E. E. F.

1414. *Obliquely-Crossed Cylindrical Lenses.* **S. P. Thompson.** (Phil. Mag. 49. pp. 316–324, March, 1900.)—This paper consists of an attempt to arrive at easier rules for obliquely-crossed cylindrical lenses. Sometimes ophthalmic surgeons prescribe (for the correction of astigmatism) a lens with two cylindrical curvatures on the respective faces of the lens, not crossed at right angles but at some oblique angle. As such lenses are difficult of manufacture, and as their optical effect can be precisely reproduced by a suitably calculated and more readily ground sphero-cylindrical lens, the optician desires to have simple rules for calculating the equivalent sphero-cylinder. The author discusses this problem, which is that of finding the combination consisting of one thin cylindrical lens and one spherical lens, which will be the optical equivalent of a system made up of two thin cylindrical lenses placed in contact behind one another, with their axes making with each other a certain angle. He finds that two given cylindrical components A and B may be compounded to find their cylindrical resultant C by means of a parallelogram in which, however, the angle between A and B is drawn as double the actual angle between the axes of the two given components. Hence follows a simple graphic construction for obtaining the required solution of the problem, so far as the cylindrical part of the desired equivalent combination is concerned. The author next considers the method of obtaining the corresponding expression for the power D of the spherical part of the equivalent combination, which is found to be—

$$\mathrm{D} = \frac{\mathrm{A} + \mathrm{B} - \mathrm{C}}{2}$$

The results obtained are stated in three working formulæ as follow :—

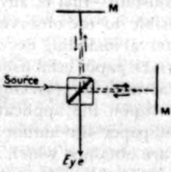
$$C = A^2 + B^2 + 2AB\cos 2\theta \qquad (1)$$

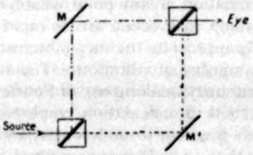
$$\text{Sin } 2\phi = \frac{B}{C}\sin 2\theta \qquad (2)$$

$$D = \frac{A + B - C}{2} \qquad (3)$$

Where θ = the angle between the axes, O*a* and O*b*, of the two given cylindrical lenses having powers A dioptrics and B dioptrics respectively; ϕ = the angle between the axis O*a* and any line O*c* drawn through O along which are taken the cylindrical components of the two given cylindrical lenses A and B. J. J. S.

1415. *Camera Lucida.* **A. Lafay.** (Comptes Rendus, 130. pp. 1122–1123, April 23, 1900.)—The camera lucida designed by Govi consists of two rectangular prisms forming, when combined, a cube. One of the faces which touch each other is covered by a very fine layer of platinum, gold, or silver, which is semi-transparent, and, in addition, a layer of Canada balsam is inserted between the two faces. Besides its original application, the author has used this apparatus for refractometric experiments, in a manner which is sufficiently indicated by the annexed diagrams. E. E. F.





1416. *Photometry of Black Bodies.* **H. Wanner.** (Ann. d. Physik, 2. 1. pp. 141–157, May, 1900.)—The author tests the validity of the Wien-Planck radiation formula,

$$J = c_1 \lambda^{-5} e^{-\frac{c_2}{\lambda T}}$$

with the aid of a König spectrum photometer, between the temperatures of 990° (absolute) and 1,570°, and the wave-lengths 0·6678 μ and 0·4861 μ. The sources of radiation were an electrically glowing platinum strip in the middle of a reflecting hollow sphere, a large porcelain vessel, and a small platinum crucible. The above formula was confirmed throughout the region specified. The logarithm of the photometric intensity was found to be a linear function of the reciprocal of the absolute temperature, and the constant c_2 was found to have the value 14509. The formula places at our disposal a simple and accurate method of determining the highest temperatures, as well as the "apparent temperatures" of the stars. Experiments with zirconia show that its brightest radiation is of the "black" type. [See also Abstract No. 1138 (1899).] E. E. F.

1417. *Kirchhoff's Law and Electrically Glowing Gases.* **E. Pringsheim.** (Ann. d. Physik, 2. 1. pp. 199–200, May, 1900.)—M. Cantor recently [see Abstract No. 1012 (1900)] described an experiment which went to show that the glowing gases in a vacuum tube do not perceptibly absorb a beam from an arc light sent twice through the tube, although they have a considerable intensity of emission. As against the conclusions drawn by Cantor, the author points out that for two reasons he need not have expected a positive result. The discharge is an intermittent one, and hence the gas is only for a small fraction of the time in a condition in which Kirchhoff's law would apply. And further, the spectrum radiated and the spectrum to be absorbed are of a very different nature, and a very narrow slit would have to be used. Besides, Liveing and Dewar have actually observed the reversal of the C and F lines, which shows that there must be absorption, though probably the absorption is much smaller than might be expected from Kirchhoff's law. E. E. F.

1418. *Luminous Motion and Fourier's Formulæ.* **Gouy.** (Comptes Rendus, 130. pp. 560–562, Feb. 26, 1900.)—The author has formerly treated the case of constant luminous motions—that is, those in which the phenomena are independent of the time, which is the ordinary case. When rays from a luminous source pass through a luminous system, experiment shows that the intensity of illumination at any point whatever is sensibly constant—that is, any variations which may occur are so rapid as to be insensible to the observer, who can only appreciate the mean intensity during an interval including necessarily a great number of vibrations. The author in his former paper established this mean intensity, making use of Fourier's formulæ. Carvallo, in remarking upon the method of calculation employed, threw doubt upon the application of Fourier's theorem to such a case, and in the present paper the author insists that by the use of Fourier's method general results are obtained which always apply, and cases realisable in nature are not left on one side. He considers that Carvallo has given no good mathematical reasons for the rejection of the large part of physical theory which would follow on the adoption of his opinion. J. J. S.

1419. *Electrostatic Images on Photographic Plates.* **W. Schaffers.** (Comptes Rendus, 130. pp. 897–898, April 2, 1900.)—Images are produced on a sensitive plate by an induction coil, using two needles as poles; the positive needle touches the plate, the negative is about half a millimetre off the plate. A sheet of metal below the plate facilitates the action. The image produced consists of a number of small black lines resembling arrows directed from the positive to the negative pole. The image is formed without development, and is insoluble in a hyposulphite of soda fixing bath. The author finds that the image is due at first to the fusion of the silver bromide and of the medium, and after prolonged action to the reduction of the bromide. Substituting iodide of gold for bromide of silver, the image consists of continuous brown lines connected by numerous ramifications. G. H. B.

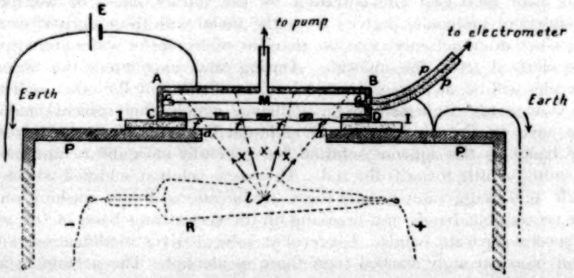
1420. *Didymium and Erbium Absorption Spectra.* **Liveing.** (Cambridge Phil. Soc., Proc. 10. pp. 213–214, Jan., 1900.)—The dilution of solutions of didymium and erbium salts produces no increase in the intensity of the absorptions when the thickness of the absorbent is proportional to the dilution. The effect of acidifying the solutions is to make the absorptions generally more diffuse, but not sensibly to weaken them, and to extend the general absorptions at the most refrangible end. A rise of temperature from about 20° C. to 97° or 98° also makes the bands more diffuse, but does not increase their intensity. It seems to the author improbable that the metallic atoms should "maintain such independence in combination as to have the same absorptions in such different compounds as chloride, nitrate, and sulphate, and it is more probable that the common absorptions are due to common products of decomposition. These might be the metallic ions, but the facts that neither dilution nor rise of temperature increases the intensity, and that acidifying does not weaken the intensity of the common absorptions, are against that supposition. Ionisation implies an electrification of the ions, which again implies a communication of energy to the field, which may probably depend on the circumstances of the encounter when the molecule of salt is broken up, and so some molecules may be broken up without being charged; while there is no reason to suppose that the absorption by a molecule would be altered by its being charged with electricity. The absorptions which are intensified by concentration and also by heat must be ascribed to the condition of the molecules during encounters, which will be more frequent in more concentrated as well as in hotter solutions. The expansion of certain bands with increased concentration by the nitrate must be ascribed to encounters of molecules derived from the metal with those derived from the acid, which are much more massive than the molecules of water and also than those derived from the chloride. During such encounters the absorbent molecules will be, as it were, loaded by the influence of the other molecules. This view seems confirmed by the influence which other solvents and other acids have on the absorptions. Didymium chloride in alcohol gives the same bands as the aqueous solution, but generally more diffuse and more or less shifted a little towards the red. The same solution acidified with hydrochloric acid exaggerates greatly these modifications, almost washing out the more refrangible bands and breaking up the very strong band in the yellow into several separate bands. Glycerol as solvent gives modifications similar to, but more strongly marked than those of alcohol. The acetate in acetic acid and the maleate in water gives similar but much less marked modifications. The tartrate and the citrate in ammoniacal solution also give similar modifications. The borate in solid glass of borax also gives bands which are unmistakably modifications of those produced by the aqueous solution. All these modifications seem to be of the same character, though of greater intensity, than the differences between the bands given by nitrate and chloride, and may be attributed to the influence of the comparatively complicated influences of the various molecules during the times of encounter. In such cases as the acid alcoholic solutions there will certainly be at least four chemical compounds mixed in the solvent, which may well produce a complicated modification of the bands without destroying their identity."

E. E. F.

1421. *Spectra of Canal and Kathode Rays.* **A. Wüllner.** (Phys. Zeitschr. 1. p. 132; Discussion, pp. 133–134, 1899. Report read before the Naturforscherversammlung in Munich.)—The author takes special care to separate the light proceeding from kathode rays, canal rays, and positive column. He finds that, whatever the material of the electrodes, the spectra observed simply depend upon the gas in the tube, but they bear a different character according to the rays from which they proceed. Thus the oxygen spectrum shows the bands in the case of the kathode rays and the lines in the case of the canal rays.

In the discussion following the reading of the paper, **Goldstein** and **Ebert** corroborated the predominant influence of the gas. The former expressed an opinion that the canal rays have a decomposing action, which accounts for the appearance of the hydrogen lines alone in the spectrum of ethylene and other hydro-carbons. E. E. F.

1422. *Electric Charge of Secondary Röntgen Rays.* **P. Curie** and **G. Sagnac.** (Comptes Rendus, 130. pp. 1013–1016, April 9, 1900.)—The authors have tested whether Röntgen rays, and the secondary rays which proceed from bodies they impinge upon, carry with them an electric charge. They found that the charge conveyed by Röntgen rays, if any, is inappreciable, but that the secondary rays, like kathode and Becquerel rays, convey a negative electric charge. The apparatus used to prove this is shown in the diagram, where M is a thin sheet of metal connected with an electrometer, and enclosed in a box A B C D of a different metal N, having windows f, f towards the Röntgen tube R covered with thin sheets of the metal N. To prevent absorption of the secondary rays by air, the box A B C D is exhausted. Under the influence of the X-rays the combination of the metals M and N acts like an electric battery whose E.M.F. produces a deflection of the electrometer. By Curie's method of opposing a piezo-electric E.M.F. derived from a piece of quartz it is possible to measure the electric current necessary to maintain the electrometer at zero. If, under these circumstances, the apparatus is exhausted, the equilibrium of the electrometer is maintained at first by the same compensating E.M.F. until the pressure falls to about 1 mm. The compensating E.M.F. then rapidly increases, soon surpasses 1 volt, and grows until a Crookes vacuum is approached. A steady current sets in, which becomes constant at a certain high exhaustion. When the metals are lead for N and platinum for M the compensating E.M.F. is about 20 volts, though 1 volt suffices at atmospheric pressure. The authors discard the explanation based upon an increased contact electrification in a vacuum. Both metals emit negative and accumulate positive electricity, but platinum is the more active, and hence it charges itself positively with respect to the aluminium. The emission of negative electricity is in direct proportion to the emission of secondary Röntgen rays. E. E. F.



1423. *Motions Produced by Röntgen Rays.* **L. Graetz.** (Ann. d. Physik, 1. 4. pp. 648–654, April, 1900.)—It is not certain that the rotations produced in vacuum tubes under the action of kathode rays is directly due to the impact of projected particles. The rotations appear at low pressures long before there is any appearance of kathode rays, and they cease at exhaustions at which these rays are still present in full strength. Another argument may be based upon the author's discovery that light bodies made of dielectrics exhibit under suitable conditions rapid rotations when exposed to Röntgen rays. Radiometers do not rotate, but even experience a retarding action, evidently due to the electrostatic forces developed by the ionisation of the air. The author introduces small spheres, bells, and vanes mounted on needle-points into an electric field traversed by Röntgen rays. They begin to rotate as soon as the radiation strikes them, and continue to rotate while the rays continue. The direction of rotation depends upon the initial tendency, at least in the case of non-conductors. When a pair of copper vanes are substituted, the direction of rotation changes with the direction of the rays if the axis of rotation is normal to the path of the rays. This is easily explained by the forces acting between the negatively charged wall of the Röntgen tube and the vanes immersed in the ionised gas between the condenser plates. The latter may even be dispensed with, and so the original conditions of Crookes' rotations are approximated to. The rotations are strictly analogous to those described by Quincke in the case of liquids, and are covered by Heydweiller's theory. E. E. F.

1424. *Radiographic Stereometer.* **T. Marie** and **H. Ribaut.** (Comptes Rendus, 130. pp. 748–750, March 12, 1900.)—An improved stereometer is described by means of which the distance of the object studied can be found, not only with regard to a horizontal plane (that of the sensitive plate), but also as regards two vertical planes at right angles to each other. The stereometer consists of the apparatus previously described (March 22, 1897), but mounted in a frame which only permits of displacement in a certain horizontal line. This again is mounted in another frame which only permits of motion in a line normal to the other line, and also horizontal. Knowing the two displacements and the height of the object, as well as the height of the focus tube above the sensitive plate, the position of the object is calculated in Cartesian co-ordinates by simple formulæ. The apparatus is simple in construction and application, and its accuracy is far in excess of medical requirements. E. E. F.

1425. *E. Pabst's Antikathode for Röntgen Tubes.* **F. Kurlbaum.** (Elektrctechn. Zeitschr. 21. p. 237, March 22, 1900.)—This is an antikathode covered electrolytically with platinum black. The coating of platinum black enormously increases the heat-emissivity of the antikathode, thereby enabling it to be subjected to a much greater degree of kathodic bombardment before it becomes red-hot, with the result that the intensity of the Röntgen rays obtainable from it are very largely increased. If the antikathode does happen to get incandescent the platinum black becomes converted into platinum grey, but even platinum grey has four times the heat-emissivity of polished platinum. The object, of course, is the same as that to attain which the water-cooled antikathodes have been introduced, and is much less cumbersome and much easier to construct. R. N. L.

1426. *Radium Rays.* **E. Dorn.** (Comptes Rendus, 130. p. 1126, April 23, 1900.)—The author claims priority over Becquerel in the discovery of the electrostatic deviation of radio-active barium bromide. He also mentions another interesting discovery. Lenard had found that the action of kathode rays upon a fluorescent screen is reduced or increased by the action of an electrostatic field, accordingly as the lines of force have the same direction as the rays or the opposite direction. The same phenomenon is shown by the rays of radio-active barium. E. E. F.

1427. *New Radio-active Substance.* **A. Debierne.** (Comptes Rendus, 130. pp. 906–908, April 2, 1900.)—By treating pitch-blende with the reagents used for the extraction of metals of the iron group, and more especially of titanium and thorium, the author has succeeded in discovering a new radio-active substance which has the general characteristics of thorium but does not follow that metal through all its reactions. If a barium or bismuth salt is added to a solution of the new substance the salt added may be eliminated by means of ammonia or hydrogen disulphide without thereby eliminating the radio-activity. This proves that the latter is not due to either radium or polonium. The author calls the new substance "actinium." It produces the same phenomena of fluorescence, photographic action, and ionisation as radium and polonium. The author supposes that the new substance is the active principle of thorium radiation. E. E. F.

REFERENCES.

1428. *Spectra of Oscillating Discharges.* **G. A. Hemsalech.** (Journ. de Physique, 8. pp. 652–660, 1899.)—The author has continued the work commenced by Schuster and Hemsalech, and in the present article gives the results of his studies of the spectra of aluminium, bismuth, copper, cadmium, zinc, lead, iron, cobalt, hydrogen, oxygen, and saline solutions. Photographic comparisons of the ordinary and self-induction spark spectra are included in the present article. (See also 1899. Abstracts Nos. 1377 and 1860.) C. P. B.

1429. *Echelon Spectroscope.* **A. A. Michelson.** (Amer. Acad., Proc. 35. pp. 111–119, 1899.)—This appears to be the author's standard communication of his work to the American Society, but is practically identical with previous papers already referred to in Abstracts Nos. 1118 (1898) and 1678 (1899). C. P. B.

1430. *New Interpretation of Michelson's Spectrum Work.* **E. Carvallo.** (Comptes Rendus, 130. pp. 496–499, Feb. 19, 1900.)—This is an application of the theory of damped vibrations to explain the phenomena observed by Michelson with the interferential micrometer, from which he deduced the multiple character of radiations from their visibility curves. C. P. B.

1431. *Magnetic Perturbations of the Spectral Lines.* **T. Preston.** (Roy. Dublin Soc., Trans. 7. pp. 7–22, 1899.)—The substance of this paper has been published in the Phil. Mag. (vol. 47. p. 165, 1899. See also Abstract No. 1000, 1899), but appears here in a complete form. From the work carried out by the author it appears that the observation of the radiating phenomena in the magnetic field is likely to afford a valuable means of inquiry into the so far hidden nature of the events which bring about the radiation from a luminous body, and also to give us, perhaps, some clearer insight into the structure of matter itself.

[For notices of earlier work by the same author on this subject, see Abstracts Nos. 755 and 1032 (1898), and 477 (1900)]. J. J. S.

1432. *Dispersion of Light in the Electromagnetic Theory.* **A. Antonelli.** (N. Cimento, 10. pp. 372–379, 1899.)—A mathematical paper, working out the results of considering molecules, apart from one another in the ether, as minute Hertzian resonators. It does not lend itself to abstracting. A. D.

1433. *Photography by Röntgen Rays.* **T. Guilloz.** (Comptes Rendus, 130. pp. 355–357, Feb. 5, 1900.)—Discussion of difficulties in clinical radiographic work, arising from the production of secondary rays by surrounding objects, including the body of the operator, and by the body of the patient. A. D.

HEAT.

1434. *Law of Atomic Heat.* **S. Meyer.** (Ann. d. Physik, 2. 1. pp. 135–140, May, 1900.)—In comparing the atomic and molecular volumes with the atomic and molecular magnetisms of elements and compounds it has been shown that a contraction of volume attending the formation of compounds leads to an increased magnetic susceptibility, and an expansion leads to a decrease. The author has established a similar relation for atomic and molecular specific heats. According to Richarz a small atomic weight combined with a small atomic volume foreshadows a deviation from Dulong and Petit's law. During combination the masses are added, but the volume may be greater or smaller than the sum of the atomic volumes. In the case of contraction deviations from the additive law of Joule, Kopp, and Neumann are to be expected, a greater dependence upon the temperature coming into play. Also the molecular heat comes out smaller than the sum of the atomic heats at the same temperature. In the case of expansion the opposite might occur. The greater dependence upon the temperature can hardly be proved as yet, but comparisons at the same temperature go to confirm the suppositions stated. Thus the following substances show a strong concentration and also a distinct decrease in the molecular heat: Sb_2S_3, FeS_2, MnS, $PbBr_2$, KBr. On the other hand, Cu_2I_2, and AgI show an expansion and an increase of molecular heat. SnS_2, which contracts, shows an irregular behaviour. Assuming the atomic heat of oxygen to be 4·9, the author shows that the same rules hold good for a large number of oxides, some of which contract, while others expand on formation. The only exceptions so far are B_2O_3 and Bi_2O_3. E. E. F.

1435. *Liquid Mixtures of Constant Boiling-point.* **G. Ryland.** (Chem. News, 81. pp. 15–16, Jan. 12; 42–43, Jan. 26; and 50–51, Feb. 2, 1900. From the American Chemical Journal, vol. 22, Nov., 1899.)—The author examined eighty binary mixtures of liquids mutually soluble in all proportions, and two mixtures of liquids whose mutual solubilities are limited. He found that forty-five of the former give distillates which boil at a constant temperature, the ratio of the components in the distillate then being nearly that of the products of the vapour densities and vapour pressures of the pure liquids at that temperature; that both of the latter mixtures form distillates with the like property so long as there are two layers of liquids in the distilling flask; that these distillates are, however, not true chemical compounds. A historical sketch of the work previously done in this regard is given, and the author's arrangement for distillation under reduced pressure is described, as well as, in fuller detail, his work on mixtures of methyl alcohol and of ethyl alcohol with benzene. R. E. B.

1436. *Cooling of Saturated Steam by Free Expansion.* **J. H. Grindley.** (Roy. Soc., Phil. Trans. 194. pp. 1–36, Feb. 19, 1900.)—In a paper on the Dryness of Saturated Steam and the Condition of Steam Gas, read before the Manchester Literary and Philosophical Society on November 3, 1896, Osborne Reynolds describes a method of experimenting in which it is sought to determine whether by sufficient withdrawing of saturated steam at a known initial pressure and temperature the steam could be finally brought into the condition of steam gas. The method is as follows: If saturated steam be wire-drawn through a small orifice from one chamber in which the pressure is kept constant to another in which the pressure can be adjusted to have any lower value, the steam in the second chamber will become superheated, and at first the temperature will fall, but if the pressure in the second chamber can be reduced so far that the amount of superheat contained by the steam is sufficient to bring it to the condition of a perfect gas the temperature will then be unaffected by further reduction of pressure. Whether this "perfect gas" condition can be reached, is the primary object of the present research to decide.

The author gives a short theory, an account of preliminary experiments, intended to settle the best form of apparatus to be used, and describes the nature of the orifice and arrangement of the apparatus used for the final experiments. The pressure of the steam before entering the orifice was observed on a Bourdon gauge, the pressure of the wire-drawn steam by a mercury gauge. The temperature of the wire-drawn steam was determined by inserting a thermo-junction of iron and copper into the steam channel, the wires passing out of the channel through small glands. A similar thermo-junction in circuit with the first is placed in an oil bath, the temperature of which could be adjusted to any required degree. In this bath a thermometer was fixed, and the equality of temperature between the junction in the oil and the junction in the steam was shown by a galvanometer. The method of experimenting and the corrections for the pressure gauges and thermometers are described.

The first experiments showed that the chief source of error was the radiation of heat from the channel containing the wire-drawn steam; this was subsequently remedied by the use of a steam jacket. The corrected results of twenty-eight experiments made with saturated steam at temperatures varying from 240° to 380° F. are given in a table. From the results of the experiments a diagram is plotted with pressures for abscissæ and temperatures as ordinates. On this diagram the initial condition of the steam in any experiment is shown by a point on the saturation curve. A mean curve is drawn through all the points obtained by using steam in a given initial condition. The relative accuracy of the experiments is clearly shown by the fact that the greatest distance of any point representing a p-t relation in any experiment from the main curve through the points is not greater than the expected error of experiment. The first point of importance brought out by the experiments is that the steam never became a perfect gas. The curve representing the p-t relation in steam wire-drawn from a definite initial condition coincides for a short distance with the saturation curve, the length of the coincident portions varying with the initial temperature of the steam. The curvature of the lower ends of the curve of free expansion is very small and regular, even to pressures of 2·5 lbs. per square inch absolute. Hence superheated steam is never even approximately a perfect gas. The value of the specific heat of superheated steam at constant pressure is easily obtained from the curves of cooling. The experiments show a very large variation of its value with the temperature, from 0·49 at 260° mean temperature to 0·65 at 305°, but its value is practically independent of the pressure. The results from this research are compared with the values of the specific heat at constant pressure as deduced from Hirn's experiments; the variation of K_p, as shown by Hirn's experiments, is much greater than that deduced from the present experiments. [See also Abstract No. 1274 (1900).] A. S.

1437. *Specific Heat of Gases.* **E. Meyer.** (Phys. Zeitschr. 1. pp. 146–147, 1899. Report read before the Naturforscherversammlung in Munich.)—The ratio of the indicated work done in the cycle of a certain gas engine to the theoretical maximum was found to be 0·870 or 0·653, according as in the calculation of the latter the specific heats of the gases were taken to alter with the temperature according to Mallard and Le Chatelier's law or to be constant. The losses of work due to delayed ignition and to premature outflow can, however, be directly estimated from the indicator card, and on the assumption of the former figure leave too small a proportion of the loss as that due to conduction, &c.; calculation, too, on either assumption of the proportion of loss during the expansion by reason both of cooling and of imperfect combustion gives results that are incompatible with the final state of the gases as determined by chemical analysis, so that the dependence of the specific heat on pressure, as found by Lussana, seems to be real.

R. E. B.

1438. *Law of Velocity-Distribution in a Gas.* **N. D. C. Hodges.** (Phys. Rev. 10. p. 253, April, 1900.)—It is assumed that the molecules in an enclosed space form a conservative system to which the principle of least action applies; that in moving from one given point to another a given molecule will, if the time is large enough, come into contact with as many molecules as there are in the space, and that it will, if the space is large enough, pass through all possible velocities and through each velocity in proportion to the frequency of that velocity among the molecules. Maxwell's law is then easily deduced by taking an expression of the form $AN\int_0^\infty c^2\phi(c)dc$ to represent the least action. [But this expression does not follow without even further assumptions than the above.] R. E. B.

1439. *Characteristic Equation of a Fluid.* **Moulin.** (Soc. Franç. Phys., Bull. 148. pp. 9–10, May 4, 1900.)—The author has verified to a great extent his characteristic equation for any fluid, which is as follows:—

$$pw_1 = \frac{RT}{v} - \frac{b_1 w}{v^{\frac{4}{3}}} + \frac{\frac{R_1}{w_3}T}{v^{\frac{5}{3}}}$$

where p, v, T and R have the usual meaning, b_1 and R_1 are absolute constants independent of the substance, and w and w_1 are, for each substance functions of the temperature related to the same functions at the critical point by the equations—

$$\frac{w_c}{w} = 1 + \gamma\left(1 - \frac{T}{T_c}\right) \text{ and } \frac{w_1}{w_{1c}} = 1 + \gamma'\left(1 - \frac{T}{T_c}\right)$$

Finally, γ and γ' are constants characteristic of each gas. By an application of the theorem of zero area, the author calculates from the first equation the specific volume of the saturated vapour at each temperature, and the maximum vapour pressure, and finds the results to agree with experimental values obtained in the case of benzene, benzene fluoride, carbon chloride, ether, acetic acid, methyl alcohol, steam, and carbonic acid. There is a slight discrepancy in the case of carbon bisulphide. E. E. F.

1440. *Change of Density on Evaporation.* **Mathias.** (Soc. Franç. Phys., Bull. 148. p. 7, May 4, 1900.)—Away from the critical temperature, the ratio a of the heat of internal vaporisation to the change of density is a function which clearly decreases with the temperature. In the neighbourhood of the critical temperature the ratio appears to be constant, as has been proved by experiments with sulphurous acid. The author calculates the ratio from the results of Amagat, and finds that carbonic acid yields numbers which are almost rigorously constant between 0° and 15°, while between 15° and 31·35 they diminish very rapidly by about 20 per cent. Calculations based upon Young's experiments on normal hexane also yield a steadily decreasing value of *a*, but without presenting a point of inflection with a horizontal tangent, as in the case of carbonic and sulphurous acids. It appears, therefore, that the law of corresponding states does not apply to the ratio *a*. E. E. F.

1441. *Saturation Curve of Carbonic Acid.* **Mathias.** (Soc. Franç. Phys., Bull. 148. pp. 7–8, May 4, 1900.)—If, according to Amagat, one considers the loci of points, such that there is a constant ratio between the volume of the liquid and the volume of the vapour, while their joint weight remains 1 gramme, these curves have, at the critical point, horizontal tangents, except the locus of points implying an equality between the volumes of liquid and vapour respectively. This curve meets the saturation curve at a finite angle. The author shows that Amagat's locus has a horizontal tangent corresponding to a volume which is two-thirds of the critical volume. Hence the locus is geometrically curvilinear, but it is very little distant from the tangent at the critical point, which explains the result obtained graphically by Amagat.

E. E. F.

1442. *Minimum Volume of Fluids.* **D. Berthelot.** (Comptes Rendus, 130. pp. 713–716, March 12, 1900.)—The author employs Cailletet and Mathias' law of the linear diameter to calculate the volume of a liquid at absolute zero. The density of the saturated vapour is neglected in comparison with that of the liquid at the temperature in question. In this way the following molecular volumes (in c.c.) are calculated :—

N_2	O_2	Cl_2	Br_2	CO_2	SO_2	C_2H_4	CCl_4	$SnCl_4$	Ether
25·0	20·8	34·1	38·9	25·5	30	34·3	72·2	87·8	71·7
C_6H_6	C_6H_5F	C_6H_5Cl	C_6H_5Br	C_6H_5I	Pentane	Isopentane	Hexane	Heptane	
66·3	70·6	78·5	82·2	89·2	80·5	81·3	93·5	106·1	

It is stated that the deviations hitherto observed from the law of corresponding states disappear if one reckons volume from a zero equal to the co-volume as calculated above, and temperature from a special zero of temperature for each substance. F. G. D.

1443. *Characteristic Data of Gases and Vapours.* **R. Mollier.** (Phys. Zeitschr. 1. pp. 149–150, 1899. Report read before the Naturforscherversammlung in Munich.)—The author calls attention to the difference of 3 per cent. existing between Regnault's numbers for the heat of evaporation of water, and those given by Battelli and by van der Waals' equation ; the theoretical work of a steam engine is hence only known within about 3 per cent., whilst the real work as given by the indicator is not subject to such a large error. Similar errors are introduced by considering the passage of liquid to vapour as homogeneous, and by our ignorance of the exact behaviour of superheated steam. The same is the case with cooling machines using ammonia, carbonic acid, or sulphurous acid. With gas and petroleum engines differences of 30 per cent. are obtained in the efficiencies given by considering the specific heat of the combustion products, first, as constant up to 1,600°, and secondly as increasing considerably. T. H. P.

1444. *Critical Temperature of Mixture.* **N. J. van der Lee.** (Phys. Zeitschr. 1. pp. 14–15, 1899.)—Measured quantities of phenol and water were put into a Cailletet tube, and stirred to an opaque emulsion. By raising the temperature the opacity was just made to disappear. It could be made to reappear by raising the pressure, since the temperature of mixture increases with the pressure. The increase is, however, only slight, not exceeding 0·6 degrees for an increase of pressure of 180 atmospheres. On representing the results by means of van der Waals' isothermal surfaces, it appears that the co-nodal lines of the longitudinal fold and the transverse fold touch each other in a point which is also the folding point of the longitudinal fold.
E. E. F.

1445. *Critical Points.* **R. v. Hirsch.** (Ann. d. Physik, 1. 4. pp. 655–663, April, 1900.)—The phenomena observed at the critical points of pure substances and mixtures have given rise to a number of theories at variance with the simple theory of van der Waals and Andrews, notably those of de Heen, Galitzine, and Battelli. The author's experiments with pure ether, and with mixtures of ether and borneol, show that the apparent anomalies may be explained by the influence of gravitation and a retardation in attaining a state of equilibrium, without leaving the ground covered by the simple theory of van der Waals. E. E. F.

1446. *Entropy and Temperature of Radiant Heat.* **M. Planck.** (Ann. d. Physik, 1. 4. pp. 719–737, April, 1900.)—The author endeavours to find an expression for the entropy of radiant heat which is in agreement with all the data of thermodynamics, and of the electromagnetic theory of light. He is led to the conclusion that Wien's law of the distribution of energy in the spectrum is a necessary consequence of the principle of maximum entropy as applied to electromagnetic radiation. The flaws recently discovered in Wien's law in the regions of large wave-lengths, led the author to a direct calculation of the entropy of radiation which confirms the expression previously found. He also arrives at a numerical value of the temperature of a monochromatic radiation emitted by a small surface and refracted by a system of centric surfaces. The temperature of the radiation is completely defined without reference to that of the body which emits it, or to the losses suffered on the way. It is more rational to speak of the temperature of a monochromatic beam of sunlight than of the temperature of the sun, especially as the distribution of temperature in the solar spectrum differs from that of a black body. E. E. F.

1447. *Vapour-Pressures.* **R. Gahl.** (Zeitschr. Phys. Chem. 33. pp. 178–214, April 17, 1900.)—In order to measure very small vapour-pressures the author passes a measured volume of air, or, preferably, of the mixed gases resulting from the electrolysis of water, over the substance giving off vapour and then through the purest water procurable, the electrolytic conductivity of which is determined both before and after the experiment. The increase of the conductivity is a measure of the mass of vapour absorbed and consequently of its pressure, the gaseous laws being in this case applicable. By this method partial pressures of less than $\frac{1}{1000}$ mm. of mercury have been measured, and for lower pressures the experiment need only be prolonged: it is not, however, without difficulty, and the author's precautions are therefore given in detail.

The differential equation $n_1 d \log p_1 + n_2 d \log p_2 = 0$, as representing the relations between the partial pressures of a solvent and solute (n denoting number of molecules and p partial pressure) and Helmholtz's formula (in integrated form) for the relation between free energy and heat of transformation are then discussed, and are found to lead to results which agree well with the author's experiments on aqueous solutions of HCl : the pressures of these solutions are applied to measure the dissociation-pressures of the haloid salts of organic bases : an equation analogous to the above is found to hold between the pressures of NH_3 and HCl in a saturated solution of NH_4Cl, whereby the phenomena accompanying the distillation of such solutions are explained: and the partial pressures of the hydrates of H_2SO_4 and the progressive dissociation of crystalline salts with attached water, which are subject to similar relations, are also discussed. R. E. B.

1448. *Thermodynamic Theory of Muscular Cooling.* **Broca.** (Soc. Franç. Phys., Bull. 143. p. 3, Feb. 2, 1900.)—During asphyxia a tetanised muscle cools, and at the same time changes into the condition of *rigor mortis*, whereas under ordinary circumstances a muscle in action becomes heated. The author points out the thermodynamic explanation of this, in the fact that the contraction is associated with a reaction in which energy is absorbed, and compares the whole process to that of a Clark cell which encloses a vessel in which the current supplied by the cell may be employed to produce electrolysis. R. A. L.

1449. *On the Size at which Heat Movements are Manifested in Matter.* **G. F. FitzGerald.** (Nature, 61. pp. 612–614, April 26, 1900.)—In the molecular theory of heat it is assumed that the motions of very small portions of matter are the motions on which the phenomena of temperature depend. Also, according to the author, they are very irregular motions, taking place within regions too small for direct observation.

But in addition to these motions or vibrations of matter there are, as the author teaches, also motions of ether of an irregular kind, which have an amount of energy capable of estimation. And the size at which these motions are developed is comparable with the wave-length of the ether disturbances. This wave-length is perhaps a thousand times greater than molecular dimensions. For each temperature there is in ether a particular wave-length round which the vibrations are grouped.

He refers to the analogy of sound. A large body may, as regards sound waves, vibrate in unison with a small one, and so be excited by the vibration of the latter, and *vice versâ.* So it may be that the ether vibrations, which, as we are told, accompany the molecular motions on which heat depends, may give rise to electromagnetic vibrations in bodies of size comparable with the ether waves, and therefore far greater than molecular sizes. He discusses what effect such vibrations, if they exist, may be expected to have, and the possibility of their being detected. With regard to the energy of these vibrations he points out that if the energy of the fundamental vibration of a particle corresponds to its one degree of freedom according to the Boltzmann law of equal partition of energy, it will be too small to account for any observable phenomenon. But as the theory of equal partition of energy fails, according to the author, in other cases, we may be justified in expecting that the energy in question may be greater than that assigned to it by Boltzmann's law.

S. H. B.

SOUND.

1450. *Synthesis of Vowel Sounds.* **Marage.** (Comptes Rendus, 130. pp. 746–747, March 12, 1900.)—The author reproduces the various vowel sounds by means of a siren whose lower disc has a single aperture, while the upper movable disc has apertures arranged in various groups. The vowel sound *ah* is produced by closing every fourth aperture, so as to obtain groups of three separated by an interval. The pitch at which the vowel is sung is given by the number of groups per second, the vowel itself by the total number of vibrations per second. To produce the French vowel sounds *é*, *eu*, and *o*, the apertures of the movable disc must be in sets of two, separated by a closed aperture. Transition from one vowel sound to another is made by altering the width of the fixed aperture, which is widest for *o* and narrowest for *é*. For the French sounds *i*, *u*, and *ou* the apertures must all remain open as usual. To pass from one vowel to another, the width of the fixed aperture, the pressure of air, and the resonance must be altered. The vowel sounds may also be reproduced synthetically by sounding a note, and tuning a resonator to unison with the second or the third harmonic. As a practical application, the author proposes to modify the sirens used on board ship so as to give different sounds, from which an international code might be formed. E. E. F.

1451. *Analysis of Vowel Sounds.* **L. Bevier.** (Nature, 61. pp. 467–468, March 15, 1900.)—The analysis of vowel sounds was carried out by the optical enlargement of phonograph records. The author concludes that the vowels as produced by the human organs of speech are composed in the first place of two elements: that due to the vibration of the vocal chords, and that due to the resonance of the mouth and nose cavities. It is not always possible to separate clearly these two elements, but the problem is quite simple for the vowel *a*. The fundamental is due to the vocal chords, and the overtones that are strongly reinforced are due to the mouth and throat resonance. The vowel *a*, at any pitch, and pronounced by any clear voice, contains the following partial tones: (1) The fundamental to which it is sung, with the first two or three overtones. (2) The overtone or overtones whose frequencies of vibration chance to fall between 1,000 and 1,300 vibrations per second. This is the main characteristic of *a*, which serves to identify it to the ear, and remains remarkably constant, no matter what the fundamental may be. (3) The overtone and overtones whose frequencies of vibration chance to fall between 575 and 800 per second for men's voices, with a maximum at about 675; or between 675 and 900 with a maximum at about 800, for the voices of women and children. This is presumably the resonance of mouth and throat cavities resounding as one vessel, and is not as constant as the main resonance described above. The other vowels are not as yet analysed. E. E. F.

ELECTRICITY.

THEORY AND ELECTROSTATICS.

1452. *Thermo-electricity and Thermo-conduction.* **O. Wiedeburg.** (Ann. d. Physik, 1. 4. pp. 758–789, April, 1900.)—The author modifies his previous representation of irreversible processes so as to make it applicable to a physically non-homogeneous body, such as a metal which in consequence of local differences of temperature and potential is traversed by currents of heat and electricity. At the same time the theory is amplified, so as to include not only conduction properly so called, but also Kohlrausch's "transportation" (*Mitführung*) of one current by another, such as that of a current of entropy by an electric current. With regard to this transportation the author formulates a quantitative reciprocity involving the equality of the two transportation capacities, and shows that this assumption serves the same purpose as is usually fulfilled by the second law of thermodynamics. On this foundation the electric resistance and the coefficient of the Thomson effect come out as proportional to the absolute temperature, as actually observed. It also appears that the so-called pure thermal conduction cannot be regarded as purely thermal, since thermal changes necessarily involve changes of cohesion. Thermal conductivity thus becomes a more complex quantity, and this explains the difficulty in discovering simple relations between the two conductivities. E. E. F.

1453. *Magneto-electric Forces.* **C. Raveau.** (Soc. Franç. Phys., Bull. 145. pp. 2–3, 1900; Discussion, 146. pp. 1–2, 1900; also Journ. de Physique, 9. pp. 150–153, March, 1900.)—With reference to unipolar induction the author points out that all experiments on closed circuits are equally well explained on the supposition that a magnet revolving about its axis drags the magnetic lines of force along with it, as on the supposition that it does not. If it be admitted that the lines of force follow the motion of the magnet, no deductions from that supposition can be experimentally verified, as a magnet which would be strictly symmetrical about its axis cannot be practically realised. Even if it could, Maxwell's theory would seem to indicate that the magnetic field could be slightly changed, and an electrostatic field would be produced.

In discussing the above paper, **Crémieu** remarks that if the existence of electric convection currents is admitted, a linear current can theoretically be increased in strength by imparting to the conductor a velocity along its length. Similarly, the magnetic field due to a solenoid should be increased by making the solenoid revolve about its axis in the direction of flow of the current traversing it. This reasoning cannot be directly applied to a permanent magnet, as the analogy is not certain to hold good.

A. Blondel refers to the experiments of Lecher, which appear to him to confirm Faraday's view and to decide against the attachment of the lines of force to the magnet itself. In the reverse case, the lines of force in the gap between two bar magnets placed end to end would be bent by twirling the magnets in opposite directions. [See also Abstracts Nos. 94 and 850 (1900).] E. E. F.

1454. *Thermo-magnetic Phenomena.* **G. Moreau.** (Comptes Rendus, 130. pp. 562–565, Feb. 26, 1900.)—A mathematical paper in which the author seeks to show that his interpretation of the thermo-magnetic effect of Nernst differs from that of Voigt, and that it is confirmed by experiment. He concludes that under the action of a magnetic field only the thermo-electric forces relative to the Thomson effect undergo the Hall effect. J. J. S.

DISCHARGE AND OSCILLATIONS.

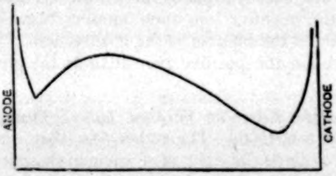
1455. *Dissociation Theory of the Electric Arc.* **C. D. Child.** (Phys. Rev. 10. pp. 151–160, March, 1900.)—By photographing a narrow longitudinal section of an alternate-current arc on a long moving film, Brown showed that the arc is formed by the coalescence of two light-fronts, starting from the positive and negative carbons respectively [see 1899, Abstract No. 1720]. The negative light-front starts first, but the positive one moves with the greater velocity. The former circumstance is easily explained, as the negative carbon was positive during the previous half-period, and was therefore the hotter of the two. As regards the difference of velocity, it is difficult to account for it without having recourse to some ionic hypothesis. Such an hypothesis has been framed by the author, who supposes that the negative ions move more slowly than the positive ions. This is the reverse of what happens in the case of dissociation by Röntgen rays. The greater velocity of the positive ions would not only explain the fact observed by Brown, but also the greater fall of potential at the positive pole. Manometric experiments show that the pressure near the positive carbon is greater than that near the negative carbon. The author explains this on the ground that owing to the smaller speed of the negative ions their number between the poles at any given time must exceed the number of the positive ions. Hence they exert a greater attraction upon the positive pole than do the positive ions upon the negative pole. E. E. F.

1456. *Magneto-Optic Effect on Vacuum Tubes.* **Dongier.** (Soc. Franç. Phys., Bull. 147. pp. 5–6, 1900.)—The author describes a new arrangement for showing the polarisation of the light of a vacuum discharge in a direction at right angles to the magnetic field which envelopes it. As regards the explanation proposed by Egoroff and Georgiewsky [see 1900, Abstract No. 1289], ascribing the phenomenon to the magnetic displacement of the luminous thread and consequent changes in the reflection and refraction due to the glass walls, the author remarks that, if that explanation were true, the behaviour of different gases must be identical, whereas hydrogen and nitrogen show characteristic differences, and so do helium and argon. Cotton proposes an explanation based upon the supposed existence of an absorbing gaseous layer which is crowded out when the luminous thread is pressed against the wall. If this is true, the phenomenon must disappear in a magnetic field which is strictly uniform. E. E. F.

1457. *Electrostatic Deflection of Kathode Rays.* **A. Heydweiller.** (Phys. Zeitschr. 1. pp. 15–16, 1899.)—Spherical vacuum tubes of the ordinary Röntgen ray pattern were used, but the polarity of the electrodes was reversed, so that the antikathode, instead of reflecting the kathode rays at right angles, cast a shadow on the wall opposite the original anode. On approaching a rubbed ebonite rod to the tube, a considerable but momentary enlargement of the shadow was observed. A rubbed glass rod produced a corresponding contraction. Under favourable conditions, the dimensions of the shadow could be doubled or halved respectively. A permanent enlargement was produced by putting the antikathode to earth, and this enlargement was perceptible even in the case of strong discharges, whereas the other deflections required very weak currents. If any part of the stem of the antikathode was left uncovered, the change in the dimensions of its shadow was very much more pronounced than the other changes. A curious point noticed is that the approach of the charged body produces in the first instance a disappearance of the phosphorescence on the wall, succeeded by the temporary appearance of the modified shadow. E. E. F.

1458. *Use of Braun's Kathode Ray Tube.* **L. Kallir.** (Zeitschr. Elektrotechn., Wien. 18. pp. 138–142, March 18, 1900.)—The author has worked out several additional methods of employing the Braun tube for the study of electric and magnetic processes. The fluorescent screen is fixed, and the curves are not drawn out by a lateral motion. The circles or ellipses obtained on the screen are photographed, and used for the evaluation of the energy of a current in watts, and for the quantitative determination of hysteresis in iron. In the case of the latter, the kathode beam is exposed to deflection by two fields at right angles to each other, one due to the magnetising current, and the other to the magnetised body itself. The combination of the two deflections thus yields directly the ordinary hysteresis curves. E. E. F.

1459. *Electric Conductivity of Gases.* **J. Stark.** (Ann. d. Physik, 2. 1. pp. 62–71, May, 1900.—In a gaseous discharge, the speed of the negative ions is in general greater than that of the positive ions. This leads to an accumulation of ions at the anode at the expense of the kathode, and to an increase of conductivity near the anode. This increase is marked by the constant production of new ions at the kathode, by the activity of the kathode rays in lowering the resistance of the gas, and by heat effects. The production of undiffused ions leads to a large increase of resistance at both the electrodes. Neglecting the heat effects, which cannot be at present precisely determined, the author gives the annexed diagram as a typical representation of the specific resistances at various points between the anode and kathode. He verifies it by sending a transverse current through auxiliary electrodes. E. E. F.



1460. *Electric Oscillations in a Free Wire.* **M. Abraham.** (Ann. d. Physik, 2. 1. pp. 32–61, May, 1900.)—The experimental results of Sarasin and Birkeland obtained in 1893 with respect to the electrodynamic occurrences in the field of a wire having a free end are of practical interest now that wireless telegraphy is carried on by such wires. The complete reduction of the phenomena to Maxwell's theory is not possible with the present means of analysis. The author therefore supposes the wire to have the shape of a very elongated paraboloid of revolution. The field surrounding the wire is to change periodically, in such a manner that the lines of force are always normal to the surface. He obtains a convergent series, in the solution of which he pays special attention to the distribution of current and charge along the conductor, and to the displacements of energy in the field. E. E. F.

1461. *Electromagnetic Dispersion of Ice.* **C. Gutton.** (Comptes Rendus, 130. pp. 1119-1121, April 23, 1900.)—By means of his method used for comparing the rates of propagation of electric waves through bitumen with and without wires, the author has determined the dielectric constant and electromagnetic dispersion of ice. The refractive index was found to be 1·76, which would give a dielectric constant of 3·1. The ice was perfectly limpid and dry, and was examined at a temperature a little below zero. It did not perceptibly absorb the electric waves. The value found for the dielectric constant is much higher than that obtained by Blondlot by a different method, and the author therefore suspected that ice would show considerable dispersion for different wave-lengths. The original method not being available for great wave-lengths, he used that devised by Blondlot, in which the wave-length proper to the same resonator is measured first in air and then in the medium under investigation. The refractive indices thus obtained cover wave-lengths ranging from 14 to 2,000 cm. For the smallest wave-length the refractive index is 1·76, as already stated. This becomes 1·73 for a wave-length of 25 cm., and so it goes on decreasing with increasing wave-lengths until it reaches 1·50 at a wave-length of 2,088 cm. This gives a dielectric constant of 2·25, which is not far from Blondlot's value of 2·0 found in still greater wave-lengths. Within the region investigated the dispersion of ice is normal. E. E. F.

1462. *Coherer Action.* **J. Härdén.** (Elektrotechn. Zeitschr. 21. pp. 272-273, April 5, 1900.)—The author desired to examine a coherer while cohering under the microscope. For this purpose he constructed a coherer capable of coming into the field of the microscope and consisting of two fine wires adjusted by micrometer sirens. By a special and very ingenious contrivance the wires were so adjusted that a galvanometer, connected in series with them to a cell, just failed to indicate. When exposed to electric radiation sparks were seen to jump from one wire to the other. On reversing the direction of the current in the sender the direction of the sparks in the receiver was also reversed. Not until the wires were brought with their ends only 0·005 mm. apart did the galvanometer indicate a current when the sparks passed. When steel wires were observed under similar conditions and approached to 0·006 mm. from each other, while sparking under the action of the electric wires, a dark bridge sprang across between them and then the galvanometer indicated. Little particles of metal could be observed passing from the one wire to the other previously to the formation of the bridge. Shaking destroyed the bridge and caused the galvanometer needle to return to zero. R. N. L.

1463. *Hertz Oscillator.* **R. Swyngedauw.** (Comptes Rendus, 130. pp. 708-711, March 12, 1900.)—According to Poincaré and Bjerknes, the vibrations of a Hertz oscillator are similar to those of a damped pendulum in which the intervals between consecutive zeros of intensity are equal, and most resonance experiments confirm this. But the author is of opinion that the question is not quite settled and that the oscillator may produce successively a series of complex oscillations for which the intervals between two successive zeros are unequal. One set of experiments for the purpose of investigating this point is described. The discussion of them is not complete. D. E. J.

1464. *Coherer Phenomena.* **F. Campanile** and **G. di Ciommo.** (Elect. Rev. N.Y. 36. p. 333, April 4, 1900. Translation in abstract of an article in L'Elettricistà.)—The authors prove (1) that the behaviour of a mercury globule coherer subject to the action of extra current potentials and electric waves is analogous to that of the particles in an ordinary filings coherer under the same actions; (2) that a coherer becomes conducting along certain lines and not in the entirety of its mass.

The experiments were conducted in the following manner: Upon a glass plate were fastened with Canada balsam strips of glass in such manner as to make a long, narrow rectangular cell. At the extremities of this were attached two fine copper wires, amalgamated on the ends, and in the little cell was placed vaseline oil and a small quantity of mercury which was stirred up into globules with a metallic wire. This arrangement was put in circuit with a battery of accumulators, A (fig. 1), a resistance R and a coil B. One of the two small wires *f* is connected with one point of the circuit as shown and the other left disconnected. On breaking the circuit at E, the mercury globules reunite in a fine stream. The arrangement shown in fig. 2 consists of a single cell connected in circuit with a galvanometer G, a key, and the coherer. With the arrangement as shown, the coherer introduces an enormous resistance into the circuit and the galvanometer needle does not deviate. On closing the key T the needle, of course, deviates fully, but remains in the position indicating a short-circuit when the key is opened. If, instead of the single cell, a battery of ten or twelve accumulators is used, on opening the switch T the spherical globules can be seen to unite and spread themselves out into a continuous stream.

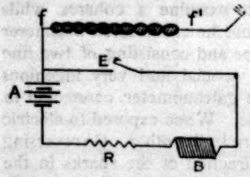


FIG. 1.

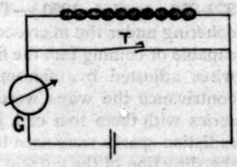


FIG 2

By using a Righi oscillator worked by an induction coil and having the mercury coherer in circuit in the usual way with a battery and galvanometer, a single spark was found sufficient to cause cohering action. Under these conditions the drops do not seem to unite as before, but the galvanometer shows a diminution of resistance, and when one side of the glass cell is removed it will be found that the end globules have connected themselves with the mercury film on the leading-in wires. A glass tube containing vaseline oil and numerous globules of mercury was found to be entirely analogous to a metallic powder coherer.

In order to show that the conductivity does not augment in the entire mass, a glass tube may be used, about 3 inches long, $\frac{3}{8}$ inch in diameter, filled with brass filings and closed at its two extremities with plugs. It is divided into equal parts along its length by exploring electrodes in the form of small brass wires run through holes in the glass. These are connected to mercury cups. If the coherer becomes conducting by the formation of chains of particles between the two end terminals for example, then, it does not follow that it will be conducting between other terminals unless these chains of particles include the entering wires of the latter. From numerous observations it was concluded by the use of this instrument that chains of conducting particles are actually formed and that the coherer does not become conducting in all its mass; that it may become conducting as a whole and still remain of high resistance from part to part, and that a coherer can become of low resistance in part without showing any diminution of resistance as a whole. E. E. F.

1465. *Maximum Sensitiveness of Coherers.* **A. Blondel** and **G. Dobkévitch.** (Comptes Rendus, 130. pp. 1123–1126, April 23, 1900.)—The increase in the sensibility of the coherer produced by Tissot by immersing it in a magnetic field is simply due to the increased cohesion of the particles, and is therefore a purely mechanical effect. The same increase of sensitiveness may be obtained by increasing the amount of filings between the electrodes, and thus increasing the mutual pressure of the particles. When the extra quantity of filings is contained in a reservoir connected with the coherer tube, the addition may be brought about by shaking the tube, though, of course, this is not so convenient as increasing the magnetic field, as in Tissot's contrivance. For maximum sensitiveness a coherer should fulfil the following conditions: The E.M.F. of the battery should remain below the critical value; the E.M.F. produced by the impinging waves should exceed the critical value; the current established on coherence should be below a certain value (usually 1 milliampere) if the coherer is not to deteriorate; the current which traverses the tube after a shock should be a very small fraction of the preceding current. With a given height of mast, the sensitiveness is, therefore, increased by reducing the critical E.M.F. This may be done by employing filings which are slow to oxidise, and by putting the tube into circuit with a battery of feeble E.M.F. and a relay of feeble internal resistance. The authors use a battery of 0·5 volts, and a tube with a critical E.M.F. of about 1 volt. The relay has a resistance of 100 to 200 ohms. It is even better to substitute for the battery a potentiometer connected with a battery of accumulators. E. E. F.

ELECTRICAL PROPERTIES AND INSTRUMENTS.

1466. *Resistance of Bismuth and Antimony.* **R. Wachsmuth** and **C. Bamberger.** (Phys. Zeitschr. 1. pp. 127–128, 1899.)—In antimony the difference in resistance amounts to 6·75 per 1,000 in zero magnetic field, and 5·79 (minimum) in a field of 8,250 c.g.s. It then increases rapidly, amounting to 1·5 per cent. in a field of 14,500 c.g.s.

With bismuth the resistance increases with the frequency of alternation, the value, with 110 alternations per second, being almost the same as the resistance to steady currents. In magnetic fields up to 16,000 c.g.s. the dependence of resistance on frequency ceases completely. G. E. A.

1467. *Thermoelectric Phenomena.* **W. F. Barrett.** (Phil. Mag. 49. pp. 309–316, March, 1900.)—The author describes the peculiar thermoelectric behaviour of a specimen of nickel steel containing 5 per cent. of manganese when coupled with an iron wire. The cool junction being kept in cold water or in ice, it was found that on heating the other junction continuously the thermo-electric force at first quickly rose; but when a certain temperature much below red heat was reached it remained almost stationary, although the hot junction was finally raised to a bright white heat. Further investigation showed that up to a temperature of 320° C. the E.M.F. of the nickel-steel alloy and iron couple rose rapidly; it then remained absolutely constant until the temperature rose to 500°, and after this only a small change occurred up to the highest temperature attainable in the gas furnace employed. The mean E.M.F. between 300° and 1,000° C. was, in round numbers, 4,000 microvolts, and the extreme variations from the mean E.M.F. throughout this range were less than 170 microvolts, or about + and — 4 per cent. of the E.M.F. at 300° C., the cooler junction being kept at 0° C. There is a slight and curious oscillation of the E.M.F. about the mean line between 300° and 1,100° C.; when the curve is plotted it is seen to cut the mean E.M.F. at four points, viz., at 310°, 540°, 810°, and 1,030° C. This singular constancy of E.M.F. through a wide range of temperature appears to occur only when iron is used in conjunction with the alloy. When mild steel is used as the second wire with the nickel manganese alloy the E.M.F. is less and remains constant only between 400° and 600° C., after which it begins to fall and continues falling slowly to the highest temperature reached (over 1,000° C.). The specific electrical resistance of this alloy is very high, being no less than 97·52 microhms per c.c. (at 15° C.). Its variation of resistance with change of temperature is comparatively small, the temperature-coefficient being 0·08 per cent. per degree C. between 0° and 250° C. J. J. S.

1468. *United States Standardising Office.* **F. A. Wolff, jun.** (Elect. World and Engineer, 35. pp. 361–365, March 10, 1900.)—The author describes the work undertaken by the U.S. Office of Standard Weights and Measures to provide accurate standards of electrical units and facilities for standardising electrical instruments.

The paper is devoted mainly to resistance standards. The office has not attempted to construct its own mercury standards, but adopts manganin coils standardised at the Berlin Reichsanstalt. It possesses coils of resistances of from 0·0001 to 100,000 ohms in decades and also of 2 and 5 ohms; these are continually compared one with another, and from time to time new coils are purchased. The method of comparison adopted is the Wheatstone-Kelvin bridge, and is fully described.

The standard of E.M.F. is the Clark cell, of which some forty are set up and compared with one another. They are found to agree in value to within 0·005 per cent. Some cadmium cells have been made, but have not yet been compared with the Clark cells.

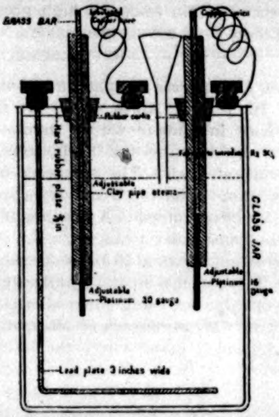
Currents are measured by the fall of potential over known resistances.

G. H. B.

1469. *Wehnelt Interrupter.* **R. Federico and P. Baccei.** (Phys. Zeitschr. 1. pp. 137–138, 1899.)—The current furnished by a Wehnelt interrupter is sent through a coil surrounding a CS_2 tube traversed by a beam of sunlight. The apparatus is furnished with nicols, arranged so that the beam is obscured on closing the circuit and passes through on breaking the circuit. The interruptions may thus be registered on sensitive paper mounted on a cylinder whose speed of revolution is measured by a chronograph. The intensity of the current is indicated by the degree of blackening of the paper. The records so obtained show the current is interrupted for about the sixth part of every period. But the interruption is graduated, and is probably never quite complete. The duration of interruption is more constant than the period. A strong magnetic field shortens the duration of interruption, but interferes with the regularity. By using a bichromate solution instead of sulphuric acid only, the commotion and heating of the interrupter is lessened, and the solution and the electrodes remain clear for a considerably longer time. E. E. F.

1470. *Improved Wehnelt Interrupter.* **W. A. Price.** (Elect. Rev. N.Y. 36. p. 357, April 11, 1900.)—The author describes an adjustable and durable type of the Wehnelt interrupter (see diagram).

The jar consists of a 5-inch by 7-inch gravity battery glass jar with a hard rubber cover. To this is fastened a lead strap 3 inches wide, which passes down one side and across the bottom, having a binding-post on top. Two ¾-inch holes in the cover are fitted with perforated rubber stoppers through which pass ordinary clay pipe-stems about 6 inches in length. Inside each is placed a piece of brass wire with a platinum tip, about 1 inch long, soldered to it with hard solder.



The interrupter is adapted for long continuous use by using a lead pipe instead of a plate for the kathode and passing a stream of cold water through it to keep the cell cool. A few turns of wire on a bolt used in series to offer a little inductance, very materially assist the working of the interrupter when used on direct current. This is not necessary, however, when used on the alternating current. E. E. F.

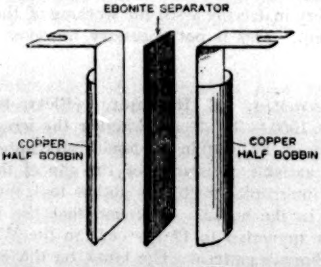
1471. *Liquid Interrupters.* **E. Ruhmer.** (Elektrotechn. Zeitschr. 21. pp. 331–334, April 26, 1900.)—To decide whether the irregularities noted by West (see 1900, Abstract No. 490) in the liquid interrupters of an induction coil are due to the variable resistance of the gap of the secondary or to irregularities in the interrupter itself, the author took mutographic impressions of the spark in the liquid. He found that the irregularity in the succession of sparks amounted to 17 per cent. in the Wehnelt interrupter, and 24 per cent. in Simon's pattern. The latter, on the other hand, showed fewer intermittences of the interruption. The irregularities are indicated to the ear by the impurity of the note emitted. Whenever regular interruptions are required, the mercury-jet interrupter designed by Boas is preferable.

E. E. F.

1472. *Direct-reading Potentiometer.* (Elect. Rev. 46. pp. 761–762, May 4, 1900.)—The subdivided resistance consists of 149 coils connected to studs arranged in a circle, and a slide wire equal in resistance to one coil. Contact is made with the studs by a slider carried on a circular disc, and the number of the stud under the slider appears below a window in the cover of the apparatus. Contact with the slide wire is made by a radial arm, the position of which is read on a scale divided into one hundred parts. In series with the subdivided resistance are two adjustable resistances which serve to bring the current to the value which makes the potentiometer direct-reading. The potential difference to be measured can be substituted for the standard cell and *vice versâ* by the motion of a double-sliding contact. All the metal connections are encased in ebonite to enable high pressures to be measured with safety. Messrs. Elliott Brothers are the makers. G. H. B.

1473. *Hot-wire Shunt Instruments as Alternating Ammeters.* **E. A. Wagner.** (Amer. Electn. 12. p. 162, April, 1900.)—It is becoming common practice to use a hot-wire instrument with a shunt, care being taken to eliminate self-induction by twisting the leads, the self-induction being negligible in the instrument itself. The reactance of the shunt will vary within wide limits depending upon the frequency, current, and the relative position of other cables carrying current. A convenient method of calibrating is to have a small current transformer arranged to slip over the cable in series with the shunt, and so wound that a 15 or 25-ampere alternating current ammeter can be used. The currents in the transformer will not be affected by the relative position of cables carrying either alternating or direct currents or by the presence of iron. Measurements of alternating currents by means of a shunt is not to be depended upon where the instrument has been calibrated by a direct current. E. K. S.

1474. *J. A. Fleming's Workshop form of Wheatstone Bridge.* (Electrician, 44. pp. 823–824, March 30, 1900.)—The most important features of this instrument are the following: The top and bottom of the box are held in place by turn-button bolts, so that, by turning four buttons, the top of the box can be at once removed, carrying with it the entire bridge mechanism. The coils are arranged as in a dial-pattern bridge, and are made as follows: Hollow half-cylinders of thin sheet copper are constructed, each having a lug, and two of these half-cylinders are put together with a thin separating piece of ebonite, and bound up with some thin silk tape. The resistance wires of manganin are then cut the proper length, and the two ends of the wire soldered to the two lugs of the copper half-cylinders, the remainder being wound non-inductively on the bobbin and tied in position by thin silk tape.



No paraffin wax is used over the coils. Each set comprises nine coils, interposed between ten brass blocks, which are arranged in a circle around a central brass ring in a kind of ebonite tray fixed on the under side of the teak lid of the box. The plugs are inserted through small holes bored through the teak lid of the box. These holes, when the box is not in use, are closed by means of circular discs of thin ebonite perforated by holes corresponding to the plug-holes in the lid. The discs turn about central pivots, and, by means of a spring, move so that the holes in the shield do not normally coincide with the holes in the box-lid. These shutters can be turned round by a common bar and finger-pin protruding through the lid. The ratio-arms are also arranged dial-fashion, 1, 9, 90, 900. The plugs are of the length of the contact surfaces only so as to prevent shouldering.

C. K. F.

1475. *Balancing Rheostat for Bolometers.* **P. G. Nutting.** (Astrophys. Journ. 11. pp. 44–46, Jan., 1900.)—The error due to varying contact makes the method of Wadsworth (Astrophys. Journ. 5. pp. 268–276) for making fine bridge adjustments, by means of a double contact arrangement for one of the battery terminals unsuitable for use with the differential bolometer in the determination of absorptive indices. The present paper describes a new device in which *both* galvanometer terminals are connected by variable contact to the bridge angles instead of only one, as is usually the case. The bridge junction at one galvanometer terminal is made of rather fine wire, of just sufficient resistance to overcome the inequalities of the bolometer arms. The other bridge junction at the remaining galvanometer terminal is made of large wire of very low resistance, and serves for the delicate final setting. The resistance of this whole wire may be made equal, within about 1 mm. or less, to that at the opposite terminal, but for rapid work it is conveniently of a resistance sufficient to balance the greatest bolometric variations expected. Further details of the arrangements and means adopted to eliminate thermal currents and variations of resistance from temperature changes are given in the paper.

J. J. S.

1476. *Shielded Galvanometers.* **H. du Bois** and **H. Rubens.** (Zeitschr. Instrumentenk. 20. pp. 65–78, March, 1900.)—The authors describe two galvanometers they have constructed, which are protected by steel shields against external magnetic disturbances.

The first is astatic with two pairs of coils, which are enclosed in a cylinder of 5 mm. steel. Outside this is a shorter cylinder of 7·5 mm. steel, which is capable of vertical motion above and below its normal position of symmetry with respect to the coils. The maximum vertical displacement of 18 mm. will compensate for a 15 per cent. difference in the moments of the two sets of magnets. Four controlling magnets are carried on rods fixed to the cover and bottom of the inner cylinder. The weight of the two shields is 5 kilos.

The second galvanometer is non-astatic, with two coils. These are surrounded by a spherical steel shell made in two halves, with a vertical plane of division; its weight is 2·3 kilos. A ring of ebonite fixed vertically on a tripod carries the two coils and the two hemispherical shells, and supports above a vertical rod carrying the controlling magnets. Of these, two are outside the shell, and two between the shell and the coils; the latter, being attached to two concentric tubes passing over the rod and through the shell, can be adjusted from the outside by cross-pieces on the tubes. The galvanometer is provided with a carrying case of steel, which is so arranged as to serve as an extra shield when the galvanometer is in use.

The coils, stands, and controlling magnets are interchangeable between the two galvanometers.

The coils are wound in hemispherical shells of 60 mm. inside diameter, which may be of fibre or of steel; in the non-astatic galvanometer steel shells are usually provided to give a better shielding. Each coil, according to its resistance, is divided into from two to four zones wound with wire of varying diameter. The central portion, which is electromagnetically valueless, is filled by a copper plug, acting as a damper. The opposing surfaces of the coils are covered with tinfoil to prevent electrostatic action, and are separated by a distance of 2·5 mm. Coils are provided of three different resistances, viz., 5, 100, and 1,000 ohms. All coils, whether in fibre or steel shells, are interchangeable, and their electrical connections are made by sliding them in place on the galvanometers.

The suspended magnet systems are made in two weights, 300 mg. and 60 mg. for the astatic, and about half these weights for the non-astatic galvanometer. The magnets are made of glass-hard tungsten steel, artificially aged; in the lighter suspension each set consists of five pairs of magnets arranged in a vertical rectangle 4 x 2·5 mm. The two magnets of each pair are curved away from each other so as to diminish their mutual demagnetising action. The precautions to be adopted in magnetising the magnets, and in hanging and astaticising the system, are discussed at length.

The shields are made of cast steel of very high permeability ($\mu = 240$ approximately in a field of 0·015 c.g.s. unit), and small coercive force of not more than 1 c.g.s. unit. They are very carefully annealed, and afterwards kept from contact with any magnet. In the galvanometers the controlling magnets are so arranged as to avoid accidental contact with the shields in taking these off and on.

The "Protective ratios" of the three shields of the non-astatic galvanometer are as follows: The coil shields, 13·3; the spherical shield, 16·6; the cylindrical carrying case, 10·9; the coil and spherical shields together, 120; the three shields together, 900. The measurements were made in a field of 0·015 c.g.s. unit.

For the intercomparison of the sensitiveness of different galvanometers the authors recommend that results be reduced to correspond with a galvanometer of resistance 1 ohm, period 1 second, and scale distance 1,000 scale divisions; in this they agree with Ayrton, Mather, and Sumpner, and Lummer and Kurlbaum. Formulæ are given for this reduction. The current-sensitiveness is then the deflection for 1 microampere, and the ballistic-sensitiveness that for 1 microcoulomb. In the case of the non-astatic galvanometer these sensitivenesses are respectively 80 and 50 for the heavy magnet system, and 800 and 500 for the light one. In the case of the astatic they are 160 and 100, and 1,000 and 630 respectively.

The authors criticise Ayrton and Mather's maximum value of $B = 5{,}000$ for galvanometer magnets, assumed in their formula for the maximum sensitiveness of galvanometers. They find a maximum coercive force in tungsten-steel galvanometer magnets of 60 c.g.s. units, and, taking a minimum demagnetising factor of 0·5, they arrive at a maximum residual value of $B = 1{,}500$. Measurements of their magnet systems show values of from 500 to 1,000, *i.e.*, from $\frac{1}{10}$ to $\frac{1}{5}$ of the value assumed by Ayrton and Mather.

G. H. B.

1477. *Magnetometer.* **Cotton.** (Soc. Franç. Phys., Bull. 148. pp. 10–11, May 4, 1900.)—The new instrument described by the author gives in a convenient manner the strength in c.g.s. units of a magnetic field whose lines are approximately horizontal. The strength of field is deduced from the force which the field exerts upon a linear conductor carrying a current of known strength. The conductor is attached to one arm of a balance, and the force exerted upon it is balanced against a weight. The conductor is a wire wrapped round the edge of a kind of paddle, so that the length upon which the force is exerted can be accurately determined, and that length is the only effective portion of the current. The form of the paddle is such that limited magnetic fields, such as that between the poles of an electromagnet, can be measured. To obtain absolute values it is only necessary to know the current traversing the wire in absolute measure. E. E. F.

ALTERNATING CURRENTS AND MAGNETISM.

1478. *Electrolytic Current Records.* **P. Grützner.** (Ann. d. Physik, 1. 4. pp. 738–757, April, 1900.)—Lichtenberg figures have been used by Koenig for obtaining some very pretty current curves, and these curves may be vastly improved by using Buerker's new Lichtenberg powder. But the method, which might be called the electrostatic method, is only available for strong currents. Moreover, the curves are not traced under the eye of the operator, but require "development" by the powder. These objections cannot be urged against the electrolytic method worked out more particularly by the author, who describes in detail the various applications of the method. He uses filter paper prepared with a potassium iodide paste, which he mounts on a revolving metal cylinder, the two electrodes, consisting of platinum springs, being lightly pressed against the paper. When a continuous current is used the anode traces a brown line, due to the evolution of iodine, while the kathode leaves no trace. When an alternating current is substituted the two electrodes make alternate traces. The frequency may be as high as 400 per second without interfering with the clearness of the traces. The only disturbing factor is a short continuance of the production of iodine after the electrode has ceased to be the anode. The intensity of the current is approximately indicated by the amount of iodine evolved, *i.e.*, by the intensity of the line. The author reproduces some beautiful records obtained in this manner. Not only are continuous and sinusoidal alternate currents shown, but also more complicated current curves are represented, as well as the "extra-currents" of induction coils. The minimum E.M.F. required is about 1 volt.

E. E. F.

1479. *Production of Asymmetrical Alternating Currents by means of Electrolytic Polarisation.* **W. L. Hildburgh.** (Elect. World and Engineer, 35. pp. 549–552, April 14, and 585–587, April 21, 1900.)—These two articles are condensations from the author's thesis for doctorate in Columbia University; they are to appear in full in the School of Mines Quarterly, July and October, 1900. The two-cell rectifier was the first form of asymmetrical conductor, worked by the production of counter E.M.F.'s. As ordinarily constructed it consisted of a Leclanché in series with a decomposition cell containing acidulated water between platinum electrodes. It was concluded that the E.M.F. of a Leclanché was too low for the passive E.M.F. On passing a direct current through such a combination so that it aids the E.M.F. of the active cell, a current will flow just as if the ohmic resistance only of the cells was present. If the impressed E.M.F. be opposed to the active E.M.F., and less than the sum of active and passive E.M.F.'s, equal to twice the passive E.M.F., no continuous current will flow; when the impressed E.M.F. is great enough to cause a flow of current, the effective E.M.F. is equal to the difference between the impressed and twice the active E.M.F. Since in the opposite direction the effective E.M.F. is always equal to the impressed, an alternating E.M.F. will cause more current to flow in one direction than in the opposite, *i.e.*, a rectification of alternating current will be produced.

The author examines the effect, on the current curve, of alterations of the area of plates, the resistance of circuit and frequency. A large number of curves were drawn, and a few are given in the first article. The author arrives at the following conclusions for theoretically perfect two-cell rectifiers: the smaller the plates the higher the efficiency—for infinitely small plates the efficiency is one; the higher the total resistance the lower the efficiency; for a particular rectifier there is a maximum value of efficiency for each frequency when the external resistance is zero; the higher the frequency the lower the efficiency—the efficiency reaching a maximum only when the frequency is zero; the efficiency referred to is what the author calls "asymmetric efficiency," and he defines this as the ratio of total to useful unidirectional current in an asymmetric conductor.

In the second article the author deals mainly with single-cell rectifiers. As an electrolyte dilute sulphuric acid seems most suitable, with hydrogen, copper, silver, lead, mercury, &c., as soluble electrodes; the results of experiments with these are given in some detail, and it is stated that the substitution of nitric acid for sulphuric acid did not greatly affect the results.

W. G. R.

1480. *Tracing Alternating Current Curves.* **F. Townsend.** (Amer. Inst. Elect. Engin., Trans. 17. pp. 75–83, Jan.; Discussion, pp. 160–169, March, 1900.)—The essential part of the apparatus required for this method is a Weston voltmeter in series with a special contact-maker; the latter consists of a disc, the perimeter of which, in a bipolar alternator, is divided into two sections; one section is conducting, and since the disc is mounted on the shaft of the machine or on that of a synchronous motor, the current can flow in the circuit of the contact-maker only during one-half of a period. During the active half-period, however, i is proportional to E the electromotive force; i will therefore be an interrupted current having the form of the E.M.F. curve, and the position of the interruption will depend on the position of the movable contact brush. The deflection of the voltmeter will be proportional to the number of impulses per sec., each impulse being proportional to the time integral of the current during the interval $t_2 - t$. Therefore—

$$\theta = \mathrm{K}\int_{t_1}^{t_2} i \, . \, dt = \mathrm{K}_1\int_{t_1}^{t_2} . \, \mathrm{E} \, . \, dt = \mathrm{K}_2\int_{t_1}^{t_2} \frac{d\mathrm{B}}{dt} \, . \, dt = \mathrm{K}_2 \, [\mathrm{B}]_{t_1}^{t_2} = \mathrm{K}_3\mathrm{B}.$$

Hence if readings are taken with different positions of the contact brush the curve of induction will be obtained.

To determine a curve of E.M.F. the alternating source of E.M.F. is sent through a small transformer; the author shows in the same way as above that $\theta = \mathrm{KE}$. The curve of induction should differ less from the sinusoidal form than the curve of E.M.F. owing to the relative amplitudes of the higher harmonics, and this fact is brought out in the curves given. The experimental curve of induction was found to coincide with the curve constructed by the laborious method of integration from the E.M.F. curve; the method described in the paper is the only one to-day which gives the induction curve directly. As a test of accuracy the curve of a complex harmonic E.M.F., determined by the author's method, was compared with the same curve obtained by the usual zero method, in which a telephone receiver is employed as indicator; a satisfactory agreement was found.

Discussion (pp. 160–169, March, 1900). **S. Sheldon** thought that in order that the instrument may give the induction curve directly the two halves of the cycle of alternation must be perfectly symmetrical. **F. Townsend** remarked that in all practical machines, and almost all alternating current machines, the positive half of the wave is the same as the negative half. **C. P. Steinmetz** explained that the present method differed from previous methods by very favourable features. Broadly speaking, the principle was: To get instantaneous readings of a quantity; we derive from this quantity another which is a differential of the former, and take integral readings, *i.e.*, average values of the latter quantity. The difficulties incidental to instantaneous readings are thus got rid of, and we are independent of the width of contact, of the impossibility of getting a point-contact of no duration, and of the difficulties of the arc following the contact brush. He did not think the determination of the induction curve by the instrument was important, but the same method can be applied wherever instantaneous values of a quantity are required, and differential values of this quantity are obtainable. **M. I. Pupin** did not think Sheldon's objection very serious, and thought Townsend had enlarged the errors likely to occur. He then introduced the problem which had evolved the present method, viz., the problem of determining "the dynamical hysteresis loop." He explained the importance of this at some length, and the use therein of Townsend's method. **Steinmetz** remarked that Bedell had attempted this method of getting the dielectric hysteresis loop of the condenser, but was not successful. W. G. R.

1481. *Magneto-electric Rotations.* **G. Jaumann.** (Ann. d. Physik, 2. 1. pp. 96–101, May, 1900. From the Akad. Wiss. Wien. S.ber. 108, iiA, Dec., 1899.)—Under the name of "a rotating magnetic flag," the author describes an ingenious apparatus for demonstrating the existence of a magnetic whirl in the interior of a conductor carrying a current. The conductor in question is a beaker filled with mercury, and the indicator is a small magnet attached with one end at right angles to a glass rod running along the axis of the beaker and mounted on pivots. Thus the "magnetic flag" is capable of rotation in a plane at right action to the direction of the current. The beaker is inserted in a tight-fitting copper vessel, which furnishes the return circuit and abolishes the external field due to the current. The bottom of the beaker is perforated to admit an electrode, which plunges into the mercury. To ensure that only the magnetic whirl inside the mercury influences the motion of the flag, the earth's magnetic field is compensated by suitable permanent magnets, and the glass rod, or flagstaff, is weighted so as to insure neutral equilibrium even out of the vertical. When the current is turned on the flag rotates with uniform velocity, the north-seeking pole following the lines of force. The considerable work spent in overcoming the resistance and viscosity of the mercury is taken out of the current, and shows itself in a counter E.M.F. impressed upon the circuit. This counter E.M.F. disappears as soon as the mercury has acquired the angular velocity of the flag. It reappears, but with the opposite sign, when the flag is artificially stopped, until the mercury itself has come to rest again. The flag rotates whether it is lacquered or left in the bare metallic state. E. E. F.

1482. *Magnetic Tests of Iron.* **H. Armagnat.** (Ind. Elect. 9. pp. 153–159, April 25, 1900.)—A description and criticism of the various methods used. In discussing Hopkinson's divided bar method, it is pointed out that errors may arise from neglecting the reluctance of the block, in which the induction is usually very low, and the permeability consequently large. A correction curve can be obtained by using a bar, for which the relation between B and H has been found beforehand. A method due to Ewing is referred to, in which the bar to be tested is cut in two and the pieces are placed side by side, each within a magnetising coil, the bars being then magnetically connected on either side of the coils by two massive iron clamps. Two measurements are made for each value of B, with different distances between the clamps. Two equations are thus obtained, each containing the reluctance of the clamps and contacts, from which this reluctance can be eliminated. Homogeneity of the bars is assumed.

The author considers that the class of instrument most suitable for commercial use is that in which B is measured by the movement of a coil placed in a narrow air-gap and carrying a current. To this class belong the instruments of Kœpsel and Kennelly, and of Siemens and Halske.

With regard to hysteresis loss, this is not appreciably influenced by the frequency of the cyclic magnetisation, provided the iron is sufficiently laminated. A 10 per cent. accuracy in testing is sufficient, in view of want of homogeneity in the specimens and alteration with time. The curious fact, discovered by Fleming, is referred to, that in a straight bar, placed in a solenoid more than 10 diameters long, there is a point where the induction B_0 is such that the actual loss in the bar is the same as it would be if the bar were magnetised uniformly with the induction B_0; this point being at a distance from one end of the bar equal to 0·22 of the length. If the solenoid is traversed by an alternating current, and a test coil is placed at the above point on the bar and connected to an electrometer, the value of B corresponding to the actual hysteresis loss is known. The loss in this, as in other cases, can of course be measured by a wattmeter, whose inductance and capacity should be small. For such work the magnetising solenoid should have few turns, so that the lag of the current may be reduced.

Results obtained with Ewing's hysteresis meter are stated to agree well with ballistic tests when the hysteresis loss is large, but not always when the loss is small. W. H. E.

1483. *Magnetic Screening.* **H. du Bois** and **A. P. Wills.** (Ann. d. Physik, 2. 1. pp. 78–83, May, 1900.)—The authors consider the theoretical and practical value of a triple screen or "armour" for galvanometers. They give equations for the "screening ratio" of spherical and cylindrical screens which are very explicit, and agree well with the observations. When the external diameters of the three spherical screens are 2·555, 4·260, and 8·056 cm. respectively, and their thicknesses 0·27, 0·18, and 0·18 cm., the individual screening ratios are 9·8, 3·7, and 2·5 respectively. The aggregate observed screening ratio is 64·6, while the screening ratio calculated from the equations given is 60·2. Some kinds of cast steel have an initial permeability of over 300. Triple screens made of such material have a screening ratio of about 1,000. The permeability of the sample subjected to the experiments above mentioned was only 151. E. E. F.

1484. *Hysteretic Qualities of Iron and Molecular Magnetism.* **S. Sheldon.** (Elect. World & Engineer, 35. pp. 211–212, Feb. 10, 1900.)—The investigations in this paper were suggested by the magnetisation of a soft iron wire by torsion and by the observation that, though a linear arrangement of strongly magnetised compass needles was stable in all positions when the needles were placed almost in contact, yet by increasing their distance apart the stability disappeared. These facts, and considerations of Ewing's molecular theory led to the supposition that the retentivity and coercivity of magnetic substances, *i.e.*, the two factors of hysteretic quality, might be dependent on the distance between their molecules. When a rod is twisted the molecules are laterally but not longitudinally compressed; and in order to test whether a longitudinal compression would produce magnetism, a rod of soft iron was hammered on its end, but no magnetism was discoverable. In order to experiment on the compass needles the earth's field was neutralised over a small area and the needles placed therein; the magnetising force was provided by the field of a long bar magnet in various positions and the strengths of these fields relatively to each other were determined by the oscillations of a magnet. The compass needles were placed (1) in linear arrangement, (2) in multiple row arrangement. In (1) it was found that the magnetising force required to break up the arrangement decreased as the distance between the pivots of the needles increased. The author draws a curve showing how the relative hysteretic loss decreases as the distance between the needles increases: it does not become zero, however, but approaches a constant value. In (2) the relation between the magnetising force required to break up the arrangement, and the distance between the rows was studied; it was found that in this case the polarity is more easily reversed owing to the influence of the rows on each other; as the distance between the rows is increased the critical magnetising force is increased because the demagnetising influence of the rows on each other is decreased. A curve is given as before, showing the variation of relative hysteretic loss with the distance between the rows.

In concluding, the author questions to what extent we can apply deductions from observations on compass needles to the treatment of iron. The results obtained show that an iron to have a small hysteretic loss should have its molecules separated along the direction of magnetisation and close together in a direction perpendicular to magnetisation. Rhoades' results (Phys. Rev., Aug., 1898) on the hysteretic qualities of strips cut from transformer iron sheets are in accord with these conclusions; owing to method of rolling, these are more dense on the edges than in the middle, and they are, moreover, less dense longitudinally than transversely. Ewing has shown that the increase with time of hysteresis loss is the result of continual baking, and Roget found that continued exposure of a good sample of iron for seven days to 160° C. trebled its hysteresis constant. W. G. R.

1485. *Time Increase of Hysteresis.* **A. H. Ford.** (Amer. Inst. Elect. Engin., Trans. 17. pp. 135–155, March, 1900.)—This increase, which was shown by Mordey and others to be due to heating, has been further examined by the author. A large number of samples of soft iron and steel, as used in the cores of transformers and armatures, were subjected to annealing or quenching at various temperatures up to 850° C., and then tested by a Ewing hysteresis meter. The value found for Steinmetz's constant, η, ranged from 0·00093 to 0·003, and higher in a few cases. (Loss in ergs per c.c. per cycle $= \eta B^{1\cdot 6}$.) The specimens were afterwards kept at a temperature of 60° C. for 29½ days, their hysteresis loss being measured at intervals. The whole change in the loss varied in different specimens from 12 per cent.

decrease to 140 per cent. increase. Neither the absolute value nor the increase in value of the hysteresis loss appeared to depend distinctly on any single impurity or pair of impurities. Nor were the results materially affected by the initial annealing or quenching, though most samples showed less increase after quenching from red heat. The best sample was an open hearth steel, having as impurities :—Si, a trace ; P, 0·027 per cent. ; Mn, 0·30 ; S, 0·05 ; combined C, 0·06. W. H. E.

1486. *Sudden Changes in Magnetising Force.* **E. Gumlich** and **E. Schmidt.** (Elektrotechn. Zeitschr. 21. pp. 233–236, March 22, 1900.)—Tests were made, with the aid of a magnetometer, to find B-H curves of iron with gradual changes in H, and also with a series of sudden changes. In the latter case soft iron is affected in the same way as by mechanical vibration : the height of the cyclic curve is unaltered, while its width may be diminished by as much as 20 per cent., as compared with the curve for gradual changes in H. With hard metal the difference between the curves is inappreciable.
W. H. E.

1487. *Unipolar Induction.* **H. Poincaré.** (Écl. Électr. 23. pp. 41–53, April 14, 1900.)—After referring to the experiments of W. de Nikolaïeve (see 1900, Abstract No. 205), the author proceeds to a critical examination of the vexed question as to whether, when a magnet which is a solid of revolution rotates round its axis, it carries its lines of force round with it or not. He establishes the following proposition : in the case of a circuit consisting of a fixed and a movable portion, the product of the current into the algebraic sum of the magnetic fluxes traversing the circles described by the sliding contacts during their rotation, is proportional to the work done by the electromagnetic forces during a complete revolution, and hence to the torque acting on the movable system ; it is further proportional to the induced electromotive force. By the aid of this proposition, all the phenomena of electromagnetic rotations are easily explained, and explained equally well whether we suppose that the lines of force are carried round by the magnet or remain stationary in space. The consideration of closed circuits thus leaves the question unanswered. The author next considers the case of open circuits. He imagines two annular flat discs of metal connected by a wire, with a similar disc of ebonite between them, arranged in a horizontal plane round the upper end of a vertical cylindrical magnet, the end of the magnet being on a level with the median plane of the ebonite disc. If the ebonite disc is rotated while everything else remains fixed, the condenser formed by the two circular discs and the disc of ebonite will become charged. But according to the theory which ascribes the induction of an E.M.F. to the cutting of lines of force by a conductor (and neglects their cutting by the disc of ebonite, regarding the latter as inert, in accordance with the views of the old electricians), no charge should appear, and that whether we suppose that the lines are fixed or move with the magnet. In this case, then, both suppositions lead to an erroneous conclusion. The author concludes by saying that the question as to the rotation or non-rotation of the lines with the magnet cannot be answered because it has no meaning. A. H.

1488. *Subsequent Magnetism.* **D. Mazzotto.** (N. Cimento, 11. pp. 81–112, Feb., 1900. Read before the Società Italiana di Fisica in Como, Sept. 22, 1899.)—The author describes experiments on what he calls "subsequent magnetism" (S.M.), a phenomenon called "time lag in the magnetisation" by Ewing. The greater number of the experiments relate to the variations that the S.M. undergoes when specimens of iron are subjected to long and repeated annealing and tempering. The apparatus consists of a reflecting magnetometer, the iron—or whatever it is—being placed in a coil alongside. The rods used were cylindrical, 60 cm. in length, and varied in diameter from 6 to 8 mm. The readings were made 0·1, 1, 2, 5, and 10 seconds after closing the circuit, and the numbers representing the S.M. are in hundredths of the total magnetism produced in the bars in 5 minutes. The samples, from various sources were as follows: I., II. Swedish iron from Cagliari, diam. 7·9 mm.; III. Swedish iron from Rome, diam. 7·0 mm.; IV. Mild iron from Professor Ascoli, Rome, diam. 6·35 mm.; V. So-called "common" iron from Cagliari, diam. 7·0 mm.; VI. Wire-drawn iron (coppered), unannealed, from Sassari, diam. 6·6 mm.; VII. Swedish iron from Cagliari, diam. 5·8 mm.; VIII. Wire-drawn iron (coppered), unannealed, from Sassari, diam. 6·9 mm.; IX. "Common" iron from Cagliari, diam. 4·8 mm.; X. "Best" iron, old sample from cabinet, diam. 6·6 mm.; XI. Mild iron as above, diam. 2·85 mm.; XII. Wire-drawn iron wire (galvanised), annealed, from Sassari, diam. 5·8 mm.; XIII. Steel, diam. 6·5 mm.; XIV. Nickel, a bundle of 23 wires, each 1 mm. in diameter.

The samples were experimented on in their natural state, as received; then annealed at a bright red heat, and cooled in air and the tests repeated. Some of the results are shown in the following tables :—

TIME.	SAMPLES.											
	I.	III.	IV.	V.	VI.	VII.	IX.	X.	XI.	XII.	XIII. Steel.	XIV. Nickel.
0″·0	29·4	13·9	12·7	12·1	5·6	30·6	6·0	—	17·0	—	1·9	0·0
0″·1	10·4	5·8	5·2	5·4	1·5	16·4	3·5	—	15·0	—	1·2	0·0
1″·0	8·1	4·0	4·4	3·1	0·7	12·5	2·8	—	11·6	—	0·8	0·0
2″·0	5·3	—	2·6	2·6	—	9·1	2·6	—	9·2	—	—	0·0
5″·0	2·0	1·4	1·2	1·8	0·5	4·4	2·0	—	5·1	—	0·6	0·0
10″·0	1·0	0·7	0·7	1·4	0·4	2.0	1·3	—	3·2	—	0·4	0·0
1′	0·3	0·4	0·3	0·5	0·0	0·5	1·0	—	1·2	—	0·0	0·0
5′	0·0	0·0	0·0	0·0	0·0	0·0	0·0	—	0·0	—	0·0	0·0
Permeability	49	23	16	21	—	29	10	—	4·4	—	10·5	1·2
0″·0	49·8	36·9	35·4	31·5	31·3	30·1	23·8	21·0	20·0	18·6	3·0	0·9
0″·1	31·5	24·9	21·5	18·1	22·2	17·9	14·8	16·9	16·7	10·9	0·8	0·8
1″·0	24·2	18·5	15·0	13·0	18·3	13·3	10·6	12·4	12·7	7·9	0·7	0·9
2″·0	16·5	—	10·3	8·8	—	9·8	7·9	—	9·0	—	—	—
5″·0	8·4	7·7	4·3	4·9	7·6	4·8	4·5	5·9	4·1	3·4	—	—
10″·0	5·3	4·7	2·0	3·0	4·5	2·3	2·8	3·9	3·0	1·8	0·5	0·1
1′	1·6	1·4	0·5	1·1	1·2	0·6	0·5	1·2	1·0	0·8	0·4	0·0
5′	0·0	0·0	0·0	0·0	0·0	0·0	0·0	0·0	0·0	0·0	0·0	0·0
Permeability	78	54	45	48	—	35	27	—	7·0	—	10·7	—

The author concludes that annealing largely increases the S.M. of metals; that wire-drawing, rolling, or hardening strongly reduces S.M.; that permeability follows very closely the variations of S.M. By reversing the order of the experiments, he finds that S.M. is exactly equal during demagnetisation, for the same interval of time, to that obtained during magnetisation.

The S.M. reaches a maximum value after annealing at a bright red heat, no matter whether the specimen be cooled slowly or rapidly.

The author also finds that the S.M. decreases with decreasing diameters; but that a bundle of wires has the same intensity of S.M. as the separate wires. If a rod has been annealed, and is then tempered by being maintained for a long time (or at repeated intervals) at a fixed temperature lower than that of annealing, its S.M. considerably diminishes, tending towards a minimum whose absolute value is lower as the temperature itself is lower. The effects of tempering on the S.M. at any given temperature may be obtained by stopping the cooling of the hot bar at the required temperature without cooling and reheating. There exists an almost perfect parallelism between the variations of S.M. due to tempering, and magnetic hysteresis. With increasing intensity of the field (which in the above experiments was 0·25 c.g.s. units), the percentage of S.M. decreases rapidly for annealed iron, but increases if the iron has been sufficiently tempered. A. G.

1489. *Change of Volume under Magnetic Force.* **G. Quincke.** (Preuss. Akad. Wiss. Berlin, S.ber. 20. pp. 391–395, April 19, 1900.)—Two large thermometer-like vessels filled with ferric chloride are placed between the poles of a powerful electromagnet, the excitation of which causes a motion of the liquid in the capillary stems of the thermometers. The change of volume is deduced from the displacement of the meniscus, the field strength being measured by a magnetic manometer. With 19 amperes exciting the electromagnet and a field strength of 3,577 c.g.s., an apparent volume change of the order of one in ten million is observed. In other experiments one thermometer has its bulb nearly full of iron chloride, and the stem is filled with water. On setting the separating surface of iron chloride and water at different levels between the pole-pieces, the field being 17,400, it is found that the apparent volume change may be positive or negative according as the separating surface is above or below the region in which the magnetic field is uniform. G. E. A.

1490. *Magnetic Orientation of Uniaxal Crystals.* **V. v. Lang.** (Akad. Wiss. Wien, S.ber. 108. pp. 557–567, 1899.)—Results are given of the examination of a number of crystals with respect to the position of the axis of greatest magnetic induction; if this coincides with the morphological axis the crystal is called +, and if not, —. The letter δ or π signifies that the crystal is dia- or para-magnetic. Tetragonal crystals —. Mercurous chloride, δ —; ammonium copper chloride, $(NH_4)_2CuCl_4 + 2H_2O$, π —; magnesium platinocyanide ($+ 7H_2O$), δ —; tinstone, π +; rutile, π +; ammonium dihydrogen phosphate, δ —; potassium dihydrogen phosphate, δ —; ammonium dihydrogen arsenate, δ —; potassium dihydrogen arsenate, δ —; calcium copper acetate, $CaCu(C_4H_6O_6)_2 + 8H_2O$, π +; urea, δ —; erythrite, π —. Rhombohedral and Hexagonal crystals —. Nickel silicofluoride, $NiSiF_6 + 6H_2O$, π +; cobalt silicofluoride, π +; potassium cadmium chloride, K_4CdCl_3, δ +; ammonium cadmium chloride, δ +; potassium ferrocyanide with potassium sodium nitrate, $K_4FeCy_6 + 2NaK(NO_3)_2$, δ +; corundum, δ +; beryl, π —; calcium sulphite, $CaS_2O_6 + 4H_2O$, δ +; strontium sulphite, δ +; lead

sulphite, $\partial +$. In magnesium chromate crystals, $MgCrO_4 + 7H_2O$, which are diamagnetic, the magnetic induction is greatest parallel to the long direction of the prisms and least along the axis perpendicular to the cleavage faces. T. H. P

1491. *Crystallisation in the Magnetic Field.* **S. Meyer.** (Akad. Wiss. Wien, S.ber. 108. pp. 513–515, 1899.)—The author finds that when solutions of various salts are allowed to evaporate in a strong magnetic field (10,000 c.g.s. units), the crystals formed are regularly orientated with regard to the lines of force. With a solution containing cobalt and zinc sulphates the mixed crystals obtained consist of long, prismatic needles having their long directions parallel to the magnetic lines. Manganese and cobalt sulphates both form rhomboidal plates the long axes of which point towards the poles. In the case of ferrous ammonium sulphate the long axis is turned perpendicular to the direction of the field; cobalt chloride also gives regularly orientated crystals. As a general rule evaporation of the solutions takes place more quickly in the magnetic field than outside it. With ferrous sulphate, nickel sulphate, potassium ferro- and ferri-cyanides, potassium bichromate, copper sulphate and bismuth nitrate, no such regular arrangement of the crystals is observed. The paper is accompanied by photographs. T. H. P.

1492. *Terrestrial Magnetic Elements of Potsdam.* **M. Eschenhagen.** (Ann. d. Physik, 2. 1. pp. 197–198, May, 1900.)—The means of the hourly values for 1899 are :—

Declination	10° 0·7′ W.
Horizontal Force	0·18818 c.g.s.
Vertical Force	0·43392 c.g.s.
Dip	66° 33·3′ N.
Total Force	0·47297 c.g.s.

The expected increase in magnetic perturbations has taken place.

The magnetic survey of Prussia has so far been confined to the eastern provinces. E. E. F.

1493. *Determination of Direction of Earth's Magnetic Field.* **G. Bongiovanni.** (N. Cimento, 11. pp. 15–32, Jan., 1900. Read before the Società Italiana di Fisica, Sept., 1899.)—A small bar of iron is placed with one pole on a line at right angles to a small compass needle feebly magnetised. In the first place let us imagine that the bar is magnetically elastic, possessing no residual magnetism. When the bar is at right angles to the magnetic field it is free from magnetism, and exercises no action on the compass needle. On rotating the bar in a horizontal plane about the pole already mentioned it becomes magnetised and deflects the needle. The two positions in which no action is exercised on the needle give a line at right angles to the magnetic meridian. Having found the magnetic meridian the bar may be rotated in a vertical plane containing the magnetic meridian. The two positions of the bar in which no action is exerted on the needle give a direction which is at right angles to the earth's magnetic field.

In practice hysteresis complicates matters; but the magnetic meridian can be determined by rotating the bar in a horizontal plane first in one direction and then in the other. The two pairs of positions in which no directive influence is exercised on the needle are symmetrically situated with regard to the line at right angles to the magnetic meridian. A similar remark applies to the next stage.

An apparatus is described which enables the above-mentioned manipulations to be carried out. An explanation is also given of the way in which the apparatus can be used to obtain the magnetic susceptibility of the bar. A. G.

MEDICAL ELECTRICITY.

1494. *E.M.F and Resistance of the Electric Organ of Malapterurus.* **F. Gotch** and **G. J. Burch.** (Roy. Soc., Proc. 65. pp. 434–445, Jan., 1900.)—The electrical discharges of an excised piece of the electric organ taken from a freshly killed fish were excited artificially by stimuli applied to it through its nerve. The piece experimented upon was 15 mm. in length, and contained approximately 530 discs. The maximum E.M.F. of the discharge was a little more than 25 volts, thus giving 0·048 volt for each disc or component of the piece examined. By calculating the total number of the discs in the entire organ of the fish it is estimated that the E.M.F. of a discharge of the whole is about 200 volts; but as the fish was artificially cooled to 5° for the experiments, it is believed that the maximum discharge at more normal temperatures would be higher than this. The shocks felt by one of the experimenters during the dissection of the fish support his measurements of the E.M.F. The low figure of 17 volts for the whole organ, as given by d'Arsonval, was probably obtained by the employment of an unsuitable method of measurement.

The resistance of the electrical organ when measured across the discs was two or three times as great as the resistance measured in a direction parallel to the disc surfaces. In each case the resistances were independent of the direction of the current between the electrodes.

The measurements of E.M.F. were taken by an electrometer and a moving photographic plate. H. L. J.

1495. *Excitation of the Electric Nerve of the Torpedo by its own Current.* **Mendelssohn.** (Comptes Rendus, 130. pp. 1274–1276, May 7, 1900.)—It is known by the experiments of du Bois-Raymond, Kühne and Hering that any motor nerve can be excited by its own current closed upon itself. In view of the analogy of structure and function which exists between a striated muscle and the electric organ, it appeared a matter of interest to ascertain by experiment whether the electric nerve of the torpedo could be excited by its own current. By a procedure similar to that known to physiologists as Kühne's nerve demarcation current experiment, the transverso-longitudinal current of the electrical nerve was closed upon itself. Experiments upon 32 torpedoes of various sizes proved the following points: (1) There is produced at closure a discharge which can be felt, and which affects the galvanometer and the telephone. A discharge at opening could not be shown owing to the conditions of the experiment. (2) The intensity of the discharge bears a direct ratio to the size and vigour of the animal; in other words, to the length and thickness of the electrical nerve. (3) Under stimulation the "demarcation current" soon gets weak, but a fresh transverse section will restore it. (4) The discharge produced by closing the nerve current does not occur throughout the entire electrical organ, but is limited to that part of the organ near the particular nerve. A series of rapid closures of the nerve current produces a series of discharges, which, however, remain distinct, and do not run into each other. In other words, a tetanus of the electrical organ is not produced.

From the foregoing facts it is evident that the electric organ of the torpedo can be excited by its own current. This method of excitation must play an important part in the process of excitation which accompanies electrogenesis in electric fishes. It is also evident that a small quantity of energy is sufficient to produce an electrical discharge in the torpedo. A nerve current at 0·015 volts closed upon itself can produce a discharge of the electric organ of from 8 to 15 volts. W. S. H.

1496. *Fibromas and "Galvano-Caustic" Treatment.* **Frédéricq.** (Archives d'Él. Médicale, 8. pp. 198–202, May, 1900.)—The author describes three cases of uterine fibromata and mentions twenty others which he has treated by electrolytic chemical cauterisation with excellent results and without any untoward accident. His conclusions are that intrauterine galvano-cauterisation with the positive pole has an evident hæmostatic action, and clearly explains the disappearance of the hæmorrhages. As to the disappearance of the symptom of pain many factors contribute. The first and chief of these is the cessation of the hæmorrhages, which, by modifying the circulation of the pelvic organs, diminishes the congestion; further, the diminution in the size of the tumour, which sometimes occurs, does away with the symptoms of compression. Lastly, there is the sedative effect on the nervous system of the galvanic current. A symptomatic cure may be obtained without a diminution in the size of the tumour. As a matter of fact, the symptoms in such cases do not bear any direct ratio to the size of the tumour.

W. S. H.

1497. *Experimental Reaction of Degeneration by Means of Injections of Strophanthine.* **J. Cluzet.** (Archives d'El. Médicale, 8. pp. 193–197, May, 1900.) —Strophanthus, as is well known, acts as a muscular poison: a few milligrammes injected into the peritoneal cavity of a frog makes the muscles inexcitable a few minutes after the injection. It seemed to be a matter of interest to ascertain through what intermediate phases the electrical reactions of the muscles pass before complete disappearance.

The experiments were made upon four groups of frogs with doses of strophanthine varying from 1 to 2 milligrammes. To make the electrical examination, the injected frog was fixed in such a manner as to permit free contraction of the gastrocnemius of one side—the contractions being registered by means of a myograph.

Results obtained: In every instance before any manifestation of abnormal electrical reactions, the reactions obtained were identical with those in the normal muscle of man, *i.e.*, the kathodic closure contraction was the first to appear, then anodic closure contraction and anodic opening contraction, lastly kathodic opening contraction.

The four groups were injected with a solution of increasing strength and the following results were obtained:—

Group 1. Weakest injection; electrical reactions continued normal for four hours after injection. Then inversion of the formula appeared, *i.e.*, anodic closure produced contraction sooner than kathodic closure. Two days after the injection electrical reaction normal.

Group 2. Electrical reactions remained normal about four hours, then reversal of the formula. Six hours after injection the muscle was tetanised by the passage of a continuous current. Seven hours after injection opening contractions no longer obtainable and Faradic excitability much diminished. Eight hours after injection Faradic excitability increased and opening contractions reappear. Inversion of the formula remains. On stimulating the trunk of the nerve the only modification observed was inversion of the formula commencing with the period of galvanic tetanisation of the muscle. Three days after, electrical reactions had returned to normal.

Group 3. Three hours after injection the muscle is tetanised by the passage of continuous current, opening contractions disappear, Faradic excitability much diminished, on excitation of the nerve trunk great diminution of Faradic excitability, inversion of the formula. Eight hours after injection Faradic excitability of the muscles was lost and all excitability in the nerve had disappeared. Thirty hours after injection muscular excitability completely lost.

Group 4. All the frogs of this group died two hours after the injection, after having showed all the successive phases above described. W. S. H.

1498. *Influence of the Anode upon the Conduction of Nerve Impulses in Man.* **S. Leduc.** (Comptes Rendus, 130. pp. 750–752, March 12, 1900.)—The conduction of impulses along a motor nerve trunk is interfered with by the proximity of the anode. The effect is shown in tracings of voluntary muscular contractions taken with an electrode placed over the course of the nerve experimented on. When the electrode is made positive a decrease is registered in the amplitude of the contractions, and this decrease is roughly proportional to the magnitude of the current passing from the electrode to the region of the nerve. The same effect of the anode upon conduction is seen with impulses set up by artificial stimulation of the nerve at points above the position of the anodal electrode. H. L. J.

1499. *Action of Currents of High Frequency and High Potential upon Chronic Pulmonary Tuberculosis.* **E. Doumer.** (Comptes Rendus, 130. pp. 602–605, Feb. 26, 1900.)—The subject has been studied during four years and upon seventeen cases, occurring in both sexes, and the following results have been obtained with considerable uniformity: The night sweats and the evening fever gradually diminish in the second week of the applications; the appetite increases, and the cough decreases during the second month. Occasionally the tubercle bacilli have disappeared from the expectoration, which also becomes diminished in quantity. The stethoscopic evidences of disease in the lungs slowly grow less. The first five cases treated have remained in good condition for fully two years since the termination of the treatment.

The mode of application consists in the brush discharge from a powerful d'Arsonval high-frequency apparatus directed to those regions of the chest and back beneath which the existence of diseased lung is suspected. The treatment lasts from five to twelve minutes at each application, and is given daily or three times a week. H. L. J.

1500. *Finsen's Phototherapy.* **S. D. Benoliel.** (Elect. World and Engineer, 35. pp. 314–315, March 3, 1900.)—The paper describes the details of an apparatus used by G. J. Hopkins, of Brooklyn, for the cure of lupus by electric light after Finsen's method. The light of an 80 ampere arc lamp is concentrated by lenses of quartz arranged in a telescopic tube in which is a water chamber to absorb the heat rays. The light comes to a focus at a distance of 4 inches from the end of the telescope. At this point it impinges upon the diseased part after passing through another arrangement of a quartz plate and a quartz lens with water circulating between them. This is called the skin lens and is attached to the part by elastic tapes. It exercises compression upon the affected surface, emptying the bloodvessels there and so rendering the tissues more transparent. H. L. J.

REFERENCES.

1501. *Ammeters and Voltmeters.* **H. Armagnat.** (Écl. Électr. 22. pp. 370–379, March 10, 1900.)—An article illustrated by good drawings, dealing with some modern instruments and their latest developments. Among others, the following are dealt with, viz., the Weston Voltmeter; Elihu Thomson's instrument for reading both volts and amperes; Karl Lehner's hot wire voltmeter; electrostatic voltmeters by Voysey, Elihu Thomson, and Weston respectively; Weston's Wattmeter; electrodynamometer by Elphinstone and Heap; J. H. Barker's recording apparatus; and Siemens' methods in connection with three-phase currents.

1502. *Evershed Moving Coil Instruments.* (Electrician, 44. pp. 664–665, March 2, 1900.)—A description is given, and the difficulties which require to be overcome in this type of instrument are pointed out.

1503. *Geissler Tube Stratifications.* **H. Pellat.** (Comptes Rendus, 130. pp. 323–325, Feb. 5, 1900.) — Experimental research, and conclusions adverse to the idea of stratification being due to anything of the nature of stationary vibrations by reflection and interference. A. D.

1504. *Molecular Magnetic Susceptibilities.* **H. du Bois** and **O. Liebknecht** (Deutsch. Phys. Gesell., Verh. 1. 12. pp. 236–240, 1899.)—A paper similar to those referred to in Abstracts Nos. 523 and 869 (1900). E. E. F.

1505. *Magnet Steel.* **O. Lang.** (Zeitschr. Instrumentenk., Beib. 20. pp. 185–187, and 21. pp. 192–193, 1899.)—These papers contain the results of experiments on the magnetisation of different steels, particularly those containing manganese or nickel, or both, in various percentages. The experiments show the particular method of hardening which gives the maximum magnetisation for each specimen tested. J. B. H.

1506. *Secular Variations of Magnetic Inclination.* **Folgheraiter.** (Journ. de Physique, 8. pp. 660–667, 1899. Extract from the Archives des Sciences Physiques et Naturelles, 8. p. 5, 1899.)—The author has in several previous papers [see 1899, Abstracts Nos. 839, 1039, 1734] described a method of determining past values of the magnetic inclination from observations of various kinds of earthenwares. The present paper is a more complete and connected statement of his work. C. P. B.

1507. *Transformer Currents under Wehnelt Interrupter.* **O. M. Corbino.** (Accad. Lincei, Atti, 9. pp. 102–107, Feb. 18, 1900.)—This is an experimental research into the sound from the interrupter, the aspect of the anode, the mean strength of the primary current, the form of the curve of the secondary current, the mean strength of the secondary current when this is unilateral, and the form in that case, all under various conditions. A. D.

1508. *Conductivities of Certain Media for a Steady Flux.* **C. H. Lees.** (Phil. Mag. 49. pp. 221–226, Feb., 1900.)—The case worked out, with diagrams, is of a medium formed of an equal number of infinitely long prisms of square cross-section, of two media having conductivities k_1 and k_2, arranged chess-board fashion (on cross-section), and bounded by two parallel equipotential planes drawn through diagonals of cross-sections of the prisms. A. D.

CHEMICAL PHYSICS AND ELECTRO-CHEMISTRY.

1509. *Seventh Annual Report of the Committee on Atomic Weights.* **F. W. Clarke.** (Chem. News, 81. pp. 146–147, March 30, and 160–161, April 6, 1900; Journal of the American Chemical Society, vol. xxii., No. 2.)—The report summarises researches on atomic weights published in 1899, the elements referred to being Mo, W, Ce, Pd, B, N, Ca, Ni, and Co. The experiments of Curie have shown that radium has a higher atomic weight than barium, although its exact value is unknown [see 1900, Abstract No. 63]. The electrochemical equivalents of copper and silver have been reinvestigated by Richards, Collins, and Heimrod [see 1900, Abstract No. 889]; the research is to be continued. A complete table of atomic weights is given. This includes the values adopted by the committee according to the two fundamental standards $H=1$ and $O=16$; those of Richards, revised for 1899; and those adopted by the German Chemical Society. Hardin's work on palladium and tungsten, and Kölle's research on cerium, have led to the only notable changes from last year. N. L.

1510. *Atomic Weights and that of Oxygen.* **E. W. Morley.** (Science, 11. pp. 281–288, Feb. 23, 1900. The President's address to the New Haven meeting of the American Chemical Society.)—After reviewing recorded values and their probable limits of error, it is pointed out that all of them rest solely on one single combination, that of hydrogen and oxygen, on their weights, or on the determination of their densities and volumetric ratio, so that all may be subject to some common error. Further work is desirable on the density of hydrogen, avoiding the use of stopcocks; also on the ratio of the combining volumes of H and O, with new precautions. But before the present value of oxygen can be received with confidence, the direct relations between H and Cl or the metals, and those between O and the metals or chlorine, must be redetermined, so that the atomic weight of oxygen may be arrived at by an independent method. S. R.

1511. *Atomic Theory from the Chemical Standpoint.* **H. N. Stokes.** (Science, 11. pp. 601–608, April 20, 1900. Paper read before a joint meeting of the Chemical and Philosophical Societies of Washington, Nov. 25, 1899.)—The author discusses the essential properties of atoms as indicated by the laws of constant and of multiple proportions, valency, &c. He calls attention to the fact that chemical laws give us no information as to the absolute nature of the atoms—that is, as to their further divisibility, unalterability, indestructibility, form, or origin; to the chemist atoms are merely centres through which energy manifests itself. A consideration of valency and isomerism, however, shows that the atoms in a molecule are combined in such a manner that there is a more intimate relation between some atoms than between others, this finding expression in structural formulæ. Further, stereo-chemical phenomena indicate that the molecule possesses a certain definite, geometrical structure, not necessarily rigid, but with no mobility of its parts analogous to that existing in the solar system. T. H. P.

1512. *Objections to the Atomic Theory.* **F. K. Cameron.** (Science, 11. pp. 608–612, April 20, 1900. Paper read before the joint meeting of the

Chemical and Philosophical Societies of Washington.)—The author discusses the case of the atomistic *versus* the mathematico-physical method of regarding matter and energy. He argues that the atomic constitution of matter, although yielding a sufficient explanation of the laws of chemical combination, is yet by no means a necessary consequence of those laws. It is pointed out that the atomic hypothesis is nothing more than an analogy with a conceivable mechanical process; as instances of the downfall, after long persistence, of such mechanical explanations of phenomena are cited the corpuscular theory of light and its successor, the undulatory theory, the hypothetical ether of the latter having been shown by Kelvin to be necessarily unstable and physically non-existent. In accounting for special phenomena the original atomic hypothesis has been modified to meet each specific case, as is evidenced by the notions regarding asymmetric carbon atoms, space isomerides, and polymers generally, varying valency, and complex or "physical" molecules determining the symmetry of crystals. It is admitted that such hypotheses have their uses, but the author points out that a knowledge of the exact relation between any hypothesis and the phenomena which it seeks to explain should be accompanied by a recognition of the retarding influence the hypothesis has had, and may still have, on the development of science. Boltzmann's views—that both the atomistic and mathematico-physical methods of representing phenomena must be regarded simply as methods, each of which possesses its own inherent advantages—are discussed, as also are Volkmann's modifications of them.

T. H. P.

1513. *Periodic Change of Reaction Velocities.* **W. Ostwald.** (Phys. Zeitschr. 1. pp. 87–88; Discussion, pp. 81 and 88, 1899. Report read before the Naturforscherversammlung in Munich.)—Following up the observations of Hittorf [see 1898, Abstract No. 1072, and 1899, Abstract No. 1744], the author has studied more closely the action of hydrochloric acid on chromium, and finds that the velocity of solution is subject to periodic changes of great regularity, as shown by the variations in the amount of gas evolved. The length of the period is decreased when the temperature is raised or the concentration of the acid increased, and is greatly influenced by the presence of other acids and salts. The phenomenon is not observed with pure chromium, and must therefore be attributed to some impurity—very probably sulphur.

In the discussion, **Kohlrausch** referred to a similar periodicity observed in the evolution of gas in the electrolysis of platinum chloride. **L. Wulff** considered that the form of the curve representing the reaction velocity indicated the simultaneous occurrence of two processes having different periods, and thus suggested an analogy with the two well-known modifications of chromium salts.

N. L.

1514. *New Periodic System.* **K. Schirmeisen.** (Zeitschr. Phys. Chem. 33. pp. 223–236, April 17, 1900.)—The basis of this arrangement is the basic or acid character of the elements combined with their chemical activity, the latter property exhibiting a more regular periodic variation as the atomic weight increases than is shown by the valency. The elements are divided into a number of groups, some of them small, containing eight members, and some larger. In the smaller groups the elements are arranged round the circumference of a circle at distances proportional to the excess of their atomic weights over that corresponding to the zero of angular measurement; whilst for the larger groups the members are spread over the circumferences of two circles placed so as to form a figure 8. This system of classification, which is discussed in detail for the several groups, comprehends all those previously proposed, and presents also the following improvements: It gives a clear representation of the changes in chemical properties among the separate members of each family—for example, the passage from acid to basic characters in the principle members of the fourth and fifth families; also it takes account of hydrogen, finds a place for copper, silver and gold, and explains special properties of separate elements, such as germanium and thallium. Further, it brings out the relation between the occurrence of coloured ions and the diminution in chemical activity and basic properties, and shows the probable existence of end-members in certain of the element-groups. The one arbitrary feature of the scheme is the determination of the atomic weights corresponding to the zeros of angular measurement for the various families. The author expresses the opinion that the chemical behaviour of the elements is conditioned by other variables besides valency, activity, and basic or acid character, and that in a complete representation of the affinity relations such other variables will have to be taken into account. T. H. P.

1515. *Cicatrisation of Crystals.* **C. Maurain.** (Journ. de Physique, 9. pp. 208–212, April, 1900.)—If a new face be produced on an alum crystal by filing, this face will disappear when the crystal is allowed to grow in an alum solution, faces parallel to those of the original crystal being formed. This healing process, however, varies according as the new face is, or is not, compatible with the symmetry of the crystal; in the former case, the face becomes first converted into a well-polished natural face and then disappears, whilst in the latter, the artificial face becomes covered with a convex deposit bounded by those natural faces coinciding most nearly with that face, this deposit then gradually disappearing under the symmetrical overgrowth. Experiments on the influence of the solvent medium on the crystalline form of potassium nitrate, sodium chloride, camphor, and mercuric chloride allow of no general conclusion being drawn. It appears, however, that when a drop of a solution is evaporated on a glass slide there is always a marked difference between the crystals formed at the edge of the drop and those formed in the interior; also crystals formed by sublimation have their edges rounded by evaporation just as ordinary crystals do when immersed in an unsaturated solution. T. H. P.

1516. *Coal Analysis.* (Elect. Rev. 46. p. 461, March 16, and pp. 504–505, March 23, 1900.)—This article is a digest of the report on coal analysis issued by the American Chemical Society. The first point on which emphasis is laid is the sampling. This must be done with great care, and the final samples carefully sealed in air-tight receptacles to obtain the correct moisture determination. The moisture is best determined by drying a finely ground sample in an open crucible at 104–107° C. To obtain this temperature a double wall bath containing toluene is recommended. Drying in vacuo over strong sulphuric acid probably gives more accurate results; but the error, which is not more than 0·37 per cent., does not render such a method necessary, seeing that the errors in sampling are likely to be far greater. The point to be observed is that the coal must be dried at a temperature above 100° C. For coals with less than 2 per cent. moisture, drying over sulphuric acid at atmospheric pressure for twenty-four hours is satisfactory; but this method is no use for lignites or coals with a high-moisture percentage.

The volatile combustible matter is tested by rapidly heating a sample in a tightly covered platinum crucible over a Bunsen burner. The difference between the loss in weight from moisture determination and this gives the required figure. Slow heating gives the yield of coke too high. The ash is determined by slowly consuming coal in an inclined crucible. The sulphur is found by Eschka's method, particulars of which are given, as also of an alternative method, viz., Atkinson's.

Examples of the comparison between the heating effects as calculated from the analysis and as found by the calorimeter are given. J. L. F. V.

1517. *Physico-Chemical Studies of Tin.* **E. Cohen.** (Zeitschr. Phys. Chem. 33. pp. 57–62, April 3, 1900; compare Abstract No. 878, 1900.)—A photograph is given showing the partial conversion of a block of Banca tin into the grey modification when innoculated with grey tin and kept at a temperature of — 5° during three weeks. The conversion of white tin into grey tin has usually been noticed only when it has been submitted to very low temperatures, *e.g.*, during a very severe winter; but since the transition-point is above the atmospheric temperature the same change should take place also under normal conditions, although exceedingly slowly. This conclusion is fully borne out by the observations of Gowland on some pewter vessels discovered near Andover by Engleheart in 1897, and now in the British Museum; they contain 94·35 per cent. of tin and 5·06 per cent. of lead, and have probably been buried since 350 A.D., and during this period have been very largely converted into grey tin.

A table is given showing the velocity of change of grey tin into white tin at temperatures between 30° and 35°. T. M. L.

1518. *Vapour Density of Bromine at High Temperatures.* **E. P. Perman** and **G. A. S. Atkinson.** (Zeitschr. Phys. Chem. 33. pp. 215–222, April 17, 1900.)—The vapour density of bromine has been determined at a number of temperatures between 600° and 1,050°. Normal values were obtained up to 750° under atmospheric pressure, but at this point dissociation begins, and at 1,050° the density falls to 75·25. The dissociation constants are calculated to be as follows:—

T	800°	850°	900°	950°	1,000°	1,050
γ	13,320	8,630	1,750	620	264	110

T. M. L.

1519. *Colloidal Metals.* **A. Lottermoser.** (Phys. Zeitschr. 1. pp. 148–149, 1899. Report read before the Naturforscherversammlung in Munich.)—The quantity of normal acid required to completely precipitate colloidal silver from its solutions is found to be inversely proportional to the strength of the acid. Alkali and ammonium salts of acids forming soluble silver salts, when added to colloidal silver solutions, throw down the colloidal metal, whilst other salts yield ordinary insoluble silver. Reducible metallic chlorides, however, are converted into lower chlorides, silver chloride also being formed; and, in this case, if the reacting solutions are very dilute, the chlorides often remain in solution in the colloidal state. By the addition of solutions of the halogens, colloidal silver is transformed into the colloidal silver haloids, and these latter are also precipitated by all electrolytes. These precipitations do not take place in presence of a stable colloid, such as gelatine or albumen, until the latter is all thrown down. The authors have also obtained colloidal mercury, bismuth, and copper, which are prepared by reducing salts of these metals by means of stannous salts. T. H. P

1520. *Catalytic Action, and Hydrolysis of Polysaccharides and the Decomposition of Esters.* **O. Šulc.** (Zeitschr. Phys. Chem. 33. pp. 47–56, April 3, 1900.)—Experiments were made on the influence of finely divided palladium on the hydrolysis of saccharose, maltose, and raffinose by water and dilute acids, and on the effect of palladium, osmium, rhodium, iridium, copper, silver, and mercury on the hydrolysis of amyl and isobutyl acetates by water at 100°. In every case a retarding action was observed, iridium being as a rule the most, and mercury the least, active in this respect. The results obtained are illustrated by curves. N. L.

1521. *Gold-Aluminium Alloys.* **C. T. Heycock** and **F. H. Neville.** (Roy. Soc., Proc. 66. pp. 20–21, Feb., 1900; Roy. Soc., Phil. Trans. 194. pp. 201–232, April 11, 1900.)—This paper contains the results of a study of the alloys of gold and aluminium, the freezing-point method being combined with a microscopic examination. The freezing-points of mixtures varying in composition from pure gold to pure aluminium are given, and the equilibrium curve for the liquid alloys and the various solids separating from them thus obtained. The authors' method of working is as follows: The freezing-point of pure gold is first determined by means of a platinum resistance pyrometer of the Callendar-Griffiths type, successive roughly weighed quantities of aluminium then being added and the freezing-point taken after each addition; a portion of each alloy is sucked up from the thoroughly molten and stirred metal by means of a Jena glass pipette, the rods of metal thus obtained being used for analysis and microscopic study. The curve having for ordinates the freezing-points and for abscissæ the corresponding atomic percentages of aluminium in the alloy consists of seven branches, each indicating a state in which a particular solid crystallises first. In the solid alloys obtained the following seven distinct substances are detected: Gold; Au_4Al; Au_5Al_2 or Au_8Al_3; Au_2Al; $AuAl$ (?); $AuAl_2$, the beautiful purple alloy discovered by Roberts-Austen; aluminium. The melting-points of the alloys, all of which, except $AuAl_2$, have a pure white colour, are: Au_2Al, 625°; $AuAl_2$, 1,062°, identical with that of pure gold; Au_5Al_2 or Au_8Al_3, 575°; Au_4Al, about 550°; the melting-point of AuAl is not furnished by the curve. There are three well-defined eutectic points: (1) at 527°, corresponding to a mixture of Au_4Al and Au_5Al_2, containing 3·6 per cent. by weight of aluminium; (2) at 569°, for an alloy containing Au_2Al and AuAl with 3·36 per cent. of aluminium; (3) at 648°, the alloy being a mixture of $AuAl_2$ and Al, containing 1·87 per cent. of gold. The lowest melting-point is hence possessed by a mixture containing only 3·6 per cent. by weight of aluminium, which depresses the melting-point of gold from 1,062° to 527°. Each eutectic point gives rise to a horizontal row of second freezing-points in the curve, and mixtures containing more than 44 per cent. and less than 60 per cent. of aluminium have three distinct freezing-points corresponding to the successive separation of three solid alloys. Photomicrographs are given of polished and etched sections of alloys of different composition, and these show that the structure of the solid alloy is in all cases in concordance with the indications of the freezing-point curve. The type of pattern of the etched surface depends on the position of the corresponding freezing-point on the curve, and in general these types are repeated at corresponding points of each branch of the curve. Thus, near a maximum point, which is the melting-point of a pure alloy, almost the whole surface of the section is filled with more or less hexagonal polygons; a little below the summit these polygons become separated by a ribbon-like network of mother substance, and still further down the curve the crystals of pure alloy are less numerous and are arranged in regular patterns, showing that they are the result of free crystallisation while surrounded by liquid ; finally, at the eutectic point, no crystals are found, the whole field of the microscope being occupied by the mother substance. Some of the alloys rich in aluminium are photographed by means of the Röntgen rays, an enlarged positive being made from the negative. By this means the structure of the alloy is shown much more clearly than by an ordinary surface photograph. T. H. P.

1522. *Chemical Dynamics of Benzene Bromination.* **L. Bruner.** (Acad. Sci. Cracovie, Bull. 1. pp. 29–37, Jan., 1900.)—The author seals up in test-tubes weighed quantities of bromine (sealed up in small bulbs) and benzene, with or without iodine. The reaction is started by breaking the bromine bulbs, and followed by titration of the free bromine with potassium iodide, and thiosulphate. With equivalent quantities the reaction proceeds asymptotically towards completion, *i.e.*, complete formation of monobrombenzene, but no velocity-constant could be obtained. Using 3 mols. benzene to 1 mol. bromine, a constant was obtained assuming a bimolecular reaction with equivalent quantities, but no satisfactory constant for the monomolecular or general bimolecular reaction. The experiments show further the great accelerating influence of iodine—an amount equal to 1 per cent. of the benzene increasing the velocity-constant tenfold. F. G. D.

1523. *Equilibria in the System, Water—Phenol—and d-Tartaric Acid or Racemic Acid.* **F. A. H. Schreinemakers.** (Zeitschr. Phys. Chem. 33. pp. 74–77, April 3, 1900.)—It is shown that dextro-tartaric and racemic acids have the same influence on the formation of two liquid layers in mixtures of water and phenol. F. G. D.

1524. *Equilibria in the System, Water — Phenol — Acetone.* **F. A. H. Schreinemakers.** (Zeitschr. Phys. Chem. 33. pp. 78–98, April 3, 1900.)—This system is of interest inasmuch as the binodal curve possesses a closed form between 68° and 92°, or in other words, if the composition of any complex be indicated by a point on a triangular diagram, then between 68° and 92° the composition of those mixtures which separate into two liquid phases will be indicated by points lying within a closed curve. The paper contains full experimental details and a useful summary of the results arrived at by the author in this and previous investigations on ternary systems possessing two or three coexistent liquid phases. F. G. D.

1525. *Decomposition of Sodium Thiosulphate by Acids.* **H. v. Oettingen.** (Zeitschr. Phys. Chem. 33. pp. 1–38, April 3, 1900.)--When an acid is added to a solution of sodium thiosulphate the liquid remains clear for a time, and then suddenly becomes turbid owing to the separation of sulphur. The author describes experiments made to determine the influence of the nature and quantity of the added acid on the reaction and also to ascertain whether any real difference exists between the metastable and the labile conditions of a supersaturated solution. When acids of different strengths are employed the increase in the time elapsing between mixing and separation of sulphur is proportional to the square of that time and to the decrease in the concentration of the hydrogen ions, and varies inversely as this concentration ; the law connecting the time and the concentration of the hydrogen ions is hence a logarithmic one. Parallel experiments with hydrochloric, oxalic, dichlor- and trichlor-acetic acids show that the nature of the acid influences the time required for the separation of sulphur only in so far as the acid is more or less dissociated ; for isohydric solutions of these acids the times are equal. The addition of sodium sulphite to the solution hinders the precipitation of sulphur, but the relation between the time and the concentration of hydrogen ions remains a logarithmic one. No definite equilibrium relations can be determined for the reaction, thiosulphate = sulphite + sulphur, owing to the secondary reaction between the thiosulphate and sulphite. The moment at which separation of sulphur takes place cannot be detected by means of conductivity determinations of the mixed solutions, nor do such measurements decide the question of the existence of a "metastable limit." Not only the precipitation of sulphur but also the further course of the reaction is a function of the concentration of the hydrogen ions of the acid. The velocity of decomposition of sodium thiosulphate has the same value for isohydric solutions of different acids. T. H. P.

1526. *Internal Pressure of Aqueous Salt Solutions.* **A. Heydweiller.** (Phys. Zeitschr. 1. pp. 114–116, Dec. 2, 1899.)—The internal pressures of aqueous salt solutions have been calculated from—(1) The capillarity constant ; (2) the compressibility ; (3) the change of volume during the solution ; (4) the change in the heat capacity. The concordance between the results obtained is shown in the table, which gives the pressure in atmospheres at different concentrations by the four methods :—

	NaCl.				KCl.			
m	p_1	p_2	p_3	p_4	p_1	p_2	p_3	p_4
0·5	118	106	108	135	—	72	108	184
1·0	223	261	211	207	223	166	222	327
1·5	328	453	309	261	320	308	317	501
2·0	433	620	397	305	414	440	405	612
3·0	689	865	566	—	638	649	577	709
4·0	981	1,100	720	—	859	790	734	—
5·0	1,212	1,381	861	—	—	—	—	—

The deviations are regarded as due in part to experimental errors and in part to the fact that the assumptions which form the basis of the calculation do not hold accurately. T. M. L.

1527. *Solubility of a Mixture of Salts possessing a Common Ion.* **C. Touren.** (Comptes Rendus, 130. pp. 908–911, April 2, 1900.)—The author has determined the solubility curves and quadruple points for the following pairs of salts at 14·5° and 25·2° respectively : KNO_3, KCl ; KNO_3, KBr. He finds that equivalent solutions of chloride and bromide have an equal effect in lowering the solubility of the nitrate, and concludes from that that they are equally dissociated. F. G. D.

1528. *Mechanism of Gelation in Reversible Colloidal Systems.* **W. B. Hardy.** (Roy. Soc., Proc. 66. pp. 95–109, March 22, 1900.)—The author distinguishes three forms in which colloidal matter can occur, viz.: (1) Fluid mixtures, or colloidal solutions (Graham's *sols*). (2) Solid mixtures of fluid and solid (Graham's *gels*). (3) Solids, such as dry silica or glass. The change from the sol to the gel may be reversible, as in the case of gelatine and water, or irreversible, as in the case of silica and water. The three-component system, gelatine-water-alcohol, is particularly amenable to experimental study, as it forms two phases which differ greatly in refractive index. Clear homogeneous solutions separate on cooling into two phases, the temperature at which this occurs depending on the composition of the mixture. These phases are at first fluid; but on further cooling, one becomes solid (solid solution), the surface of separation being curved and discontinuous. The solid solution phase is formed sometimes on the concave, sometimes on the convex side of the interface, according as the proportion of gelatine is small or large. Thus a hydrogel may consist of a solid mass containing spherical fluid droplets or of solid droplets attached to each other and forming a solid framework which mechanically encloses fluid. The two-component system, agar-water, does not give phases which can be optically distinguished, but the author assumes their existence and seeks to separate them by gentle pressure of the jelly in a long canvas packet. The effects of the ratio of the masses of the two components and of temperature on the composition of the phases are studied. In the latter case hysteresis is observed, analogous to the hysteresis in the vapour pressure-temperature curve of the hydrogel of silica observed by van Bemmelen (Zeits. f. anorg. Chem. 13. 233, 1896). The gel in the case of agar-water should, according to the phase law, form a monovariant system if it contains two phases. The author's experiments prove that the system is apparently not monovariant. This discrepancy is explained as being due to the presence of capillary forces, *i.e.*, to the existence of a large amount of surface-energy in the jelly. In the deduction of the phase law such disturbing factors are expressly excluded. F. G. D.

1529. *Stability of Irreversible Hydrosols.* **W. B. Hardy.** (Roy. Soc., Proc. 66. pp. 110–125, March 22, 1900.)—The author investigates certain systems which he prepares as follows: (1) Hydrosol of gold. Addition of two drops of ether solution of phosphorus to a litre of dilute chloride of gold solution. Dialysed for fourteen days and then concentrated by boiling. (2) Hydrosol of silicic acid. Addition of excess of hydrochloric acid to a solution of soluble glass and dialysing. (3) Hydrosol of ferric hydrate. Dialysis of the solution in ferric chloride. (4) Hydrosol of gum mastic. Addition of dilute solution of gum in alcohol to water and dialysing. (5) Hydrosol of heat-modified egg-white. Dissolving egg-white in nine times its volume of distilled water, filtering, boiling, and then dialysing.

These systems are regarded as suspensions. The author finds that the stability decreases as the *iso-electric point* is approached, *i.e.*, the point when the particles do not move in an electric field. This is proved by experiments with the proteid solution, where by addition of acid or alkali the *sign* of the charge can be changed, and so the zero point approached from either side.

Experiments on the coagulative power of salts confirm previous work and establish the following relation: "The coagulative power of a salt is determined by the valency of one of its ions. This prepotent ion is either the positive or negative ion according to whether the colloidal particles move down or up the potential gradient, *i.e.*, the coagulating ion is always of opposite electrical sign to the particle."

Defining specific molecular coagulative power, K, as the dilution in c.c. per gramme-molecule of a substance which just suffices to produce coagulation, then K varies with the valency of the active ion according to the law, $K : K^2 : K^3 = R' : R'' : R'''$. In practice this relation is complicated by the change which the specific molecular conductivity of the salt undergoes with varying concentration. For acids and alkalies the case is different. If the particles are electro-positive, acids either have no precipitating power or else this power varies with the valency according to above law. For alkalies K varies with the chemical activity of the solution. If the particles are electro-negative then alkalies either have no effect or the value of K does not vary in any simple manner with the valency. For acids K varies with the chemical activity of the solution. By "chemical activity" is here understood the value of $a(u + v)$ for any concentration, where $a =$ degree of ionisation and $u + v =$ specific molecular conductivity at infinite dilution. F. G. D.

1530. *Chemical Reactions in Solution. Vapour Pressure of the Solvent.* **A. Ponsot.** (Comptes Rendus, 130. pp, 782–785, March 19, 1900.)—This is a thermodynamical note in which the author by considering certain cyclical isothermal processes arrives at the following results: "When spontaneous and balanced reactions occur at constant temperature and pressure between the dissolved or mixed constituents of a homogeneous or heterogeneous system, then (1) they increase, up to a certain maximum value, the vapour-pressure of the solvent, provided the latter takes no part in the reaction; (2) they increase, up to a certain maximum value, the vapour-pressure of one of the reacting substances, when this body is produced in the reaction and *vice versâ.* F. G. D.

1531. *Solution Pressure.* **S. R. Milner.** (Phil. Mag. 49. pp. 417–423, May, 1900.)—This paper gives a thermodynamical proof of Nernst's equation for the contact difference of potential between a metal and an electrolyte. By means of vessels separated by semi-permeable partitions, the author has devised a circuit in which the thermodynamic cycle is reversible, and in which the phenomena at the electrodes can be considered separately. The expression he obtains is—

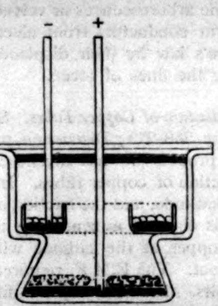
$$\phi = \frac{1}{n\epsilon}\int_{P}^{p_1} v\,dp,$$

from which Nernst's formula immediately follows by applying the gas law $pv = RT$.

If the electrolyte is not completely ionised, it is usually taken for granted that the only effective pressure in producing the potential step is that of the metallic ions. This is here shown to be thermodynamically correct if the isotherm of ionisation is taken to be that given by the law of mass action. Nernst's formula depends for its validity only on the osmotic pressure and ionisation theory, and on the reversibility of the electrolytic solution and deposition of the metal at the electrode. J. B. H.

1532. *Electrolytic Estimation of Manganese in Manganese Ore.* **A. Hiorns.** (Chem. News, 81. p. 15, Jan. 12, 1900.)—The solution of the ore, containing not more than 0·03 gm. of manganese, is made strongly acid with nitric acid, placed in a weighed platinum dish which is connected with the positive pole of a Bunsen cell, and electrolysed for twelve hours at a temperature kept as near 60° C. as possible. A platinum wire spiral dipping into the liquid is used as the kathode. The deposit of MnO_2 is washed with water, dried, converted into Mn_3O_4 by ignition, and finally weighed. N. L.

1533. *Practical Form of Normal-Element and Normal-Electrode.* **E. Bose.** (Zeitschr. Elektrochem. 6. pp. 457–459, March 1, 1900.)—The normal element shown in the figure is made by inserting a ring-shaped vessel into an ordinary desiccator glass, and has the advantages that (1) the electrode surfaces are very large, and the current-lines are very largely vertical, so that the electrodes are only very slightly affected by the passage of a fairly large current; (2) if only a small amount of crystal is present the internal resistance is very small. In all cases the mercury, covered with a layer of Hg_2SO_4, is placed at the bottom, whilst the ring contains solidified Zn or Cd amalgam covered with crystals of zinc or cadmium sulphate. The solution of zinc or cadmium sulphate is covered with a layer of liquid paraffin.



For use as a normal electrode both electrodes are made of (*e.g.*) mercury covered with calomel, and a dropping funnel is fitted into a third aperture in the cover; contact is made with the N/10 KCl solution, which fills the vessel, by means of a side tube fitted to the dropping funnel; any change in the condition of the electrode due to the passage of a current can then be immediately detected by changing from one electrode to the other. T. M. L.

1534. *Electrolytic Preparation of Indulin Dyes.* **W. Löb.** (Zeitschr. Elektrochem. 6. pp. 441–442, Feb. 22, 1900.)—A preliminary note. Results similar to those described by Szarvasy (see 1900, Abstract No. 1126), have been obtained by the kathodic reduction at the ordinary temperature of a solution of aniline and various nitro-compounds in concentrated hydrochloric acid. N. L.

1535. *Electrolysis of Sodium Chloride.* **R. Lorenz** and **H. Wehrlin.** (Zeitschr. Elektrochem. 6. pp. 389–392, Jan. 25; 408–410, Feb. 1; 419–428, Feb. 8; 437–441, Feb. 22; 445–452, March 1; and 461–464, March 8, 1900.)—In this long paper a detailed account is given of an investigation, commenced in 1896, the main lines of which have been indicated in a previous note by Lorenz (Zeitschr. Elektrochem. 4, 247). Most of the results have meanwhile been anticipated by the work of Wohlwill [Abstracts Nos. 341 (1899); and 268 (1900)]; and Foerster [Abstracts Nos. 1946 (1899); and 269 (1900)]; hence no claim to novelty is made, except as regards minor details. The bulk of the paper is unsuited for abstraction, but the primary process at the anode, both in neutral and alkaline solutions, is considered to be the formation of hypochlorite from chlorine and sodium hydroxide. When, however, the electrolytic back E.M.F. at the anode appreciably exceeds the E.M.F. of polarisation, chlorate begins to be formed at the expense of the hypochlorite. The authors incline to Wohlwill's opinion that in this latter process hydroxyl ions play an important part. N. L.

1536. *Metals Deposited under Electric Transport.* **T. Tommasina.** (Comptes Rendus, 130. pp. 325–327, Feb. 5, 1900.)—Chains of metal particles, electrolytically deposited and running from one electrode to another in distilled water, give rise in many cases to the formation of beautiful crystals, or sometimes of crystalline arborescences or velvety deposits. The chains of minute crystals may form conductors from electrode to electrode, flexible enough to show Ampere's law by their displacement: and the chains are themselves formed along the lines of force. A. D.

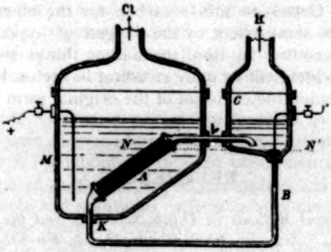
1537. *Electrolytic Production of Copper Tubes.* **S. Cowper-Coles.** (Inst. Elect. Engin., Journ. 29. pp. 258–279; Discussion, pp. 279–285, March, 1900.)—The author describes a process he has invented and named the "Centrifugal" process for production of copper tubes. In this, a *vertical* mandrel in rapid rotation is used as kathode, and the friction of the electrolyte upon the surface of the mandrel is claimed as rendering it possible to obtain smooth and dense deposits of copper at the kathode with current densities up to 190 amperes per square foot. The E.M.F. required with raw copper anodes varies from 1·0 to 1·2 volts. The electrolyte is filtered before entering the cell, and is kept in rapid circulation through it. It should contain 22·44 oz. copper sulphate (crystals) per gallon, and from 15·0 to 22·34 oz. free sulphuric acid. The former amount of free sulphuric acid is, however, the best. The electrolyte should be maintained at 150° F. Unannealed copper sheet deposited by this method showed a tensile strength of 22·1 tons per square inch. A large number of physical data and other figures relating to copper are contained in the paper, gathered from various sources of information.

In the discussion several speakers referred to processes similar to the author's, and already in use or previously described.

In his reply the author maintained the originality of his method, on the ground that none of the previous workers in this field had recognised the existence of a critical speed of rotation. Below this speed only ordinary deposits of copper are obtained at the kathode; above it, smooth and dense deposits are obtained. The critical peripheral speed is below 1,000 feet per minute. J. B. C. K.

1538. *Mercury Vats for Electrolytic Alkalies and Chlorine.* **J. B. C. Kershaw.** (Elect. Rev. 46. pp. 606–607, April 13, 1900.)—The author first gives some general information as to the two most important systems now in use, *i.e.*, the Castner-Kellner and the Rhodin system. An account is then given of the invention of two Italians, H. Grudo and J. Bisazze, and their Italian patent of December 13, 1899. In this cell there is a reversal of the disposition of kathode and anode, in such a manner that the under surface of the mercury is the active part of the kathode, and as the amalgam forms it rises through the supernatant mercury, the necessity of moving the mercury kathode being thus obviated. Ferrous sulphide is placed in the negative department of the cell, and is said to accelerate the decomposition of the mercury amalgam by water. The cause of this reaction is not quite clear, but is ascribed, by the author, to the fact that the ferrous sulphide acts as the negative element of an electrical couple.

Four different forms of cells are then described in detail for carrying out the process on the lines indicated. Hydrogen comes off with the chlorine, which is ascribed by the inventors to the decomposition of water, and by the author to the decomposition of a portion of the amalgam on the lower side of the mercury kathode. The figure shows the form of cell which has been designed to overcome this defect. A is a porous tube containing the mercury, and connected with the kathodic compartment of the cell by the non-porous tubes B, K, and L. The amalgam formed in A is displaced by gravitation, and slowly rises and passes over into C—this upward movement being also assisted by any hydrogen that may be liberated in the tube A. In C the amalgam is at once decomposed by its contact with ferrous sulphide and water, and the regenerated mercury finds its way back into A, by the tubes B and K. The enclosure of the mercury in a porous kathode tube, and the inclination of this tube in the anodic compartment of the cell in the manner shown, thus causes both the hydrogen and the amalgam to be carried into the decomposing chamber by a movement which is perfectly automatic in character; and the chlorine passing from the anodic compartments of the cell, is entirely free from hydrogen.



The disadvantages of the cell, in the author's opinion, are the use of a diaphragm with its accompanying drawbacks of increased internal resistance. Current efficiency of 95 to 100 per cent. are stated to have been obtained, but no figures as to E.M.F. required are obtainable.

Another cell, the invention of J. W. Kynaston (Eng. Pat. No. 15967 of 1898) is then explained. This is a vertical cell, in which the mercury flows zigzag fashion over narrow shelves affixed to the sides, being discharged by a pipe at the bottom. The successive shelves are supplied with transverse ridges and run-off pipes at alternate ends. Each shelf is thus constantly covered with a layer of mercury $\frac{3}{8}$ inch deep, and only the lighter amalgam passes off from it to the one below. Between these mercury shelves the vertical carbon anode is placed. The mercury amalgam is drawn off at the bottom of the cell, is decomposed in a separate vessel, and then returned to the cell. O. J. S.

1539. *Electrolytic Production of Bleaching Solutions.* **F. Foerster.** (Ind. Électrochim. 4. pp. 4–9. Jan., and 18–20. Feb., 1900; from Moniteur Scientifique, p. 90, 1900; and Die Chemische Industrie, Nov. 15, 1899.)—A lengthy article, in which the author deals, first with the chemistry of the process, and secondly with a few of the special forms of cell designed for its industrial application. In the first part the work of Fogh, Oettel, Haber and Grinberg, Bischoff and Foerster, Wohlwill, Jorre and Foerster, Müller, and of Sieverts is made use of, and the advantages and disadvantages of the various methods for lessening the losses due to reduction by hydrogen at the kathode are discussed. The author states that Müller's suggested addition of chromium salts cannot be adopted in the production of bleaching solutions, owing to the necessity for keeping such solutions colourless. The presence of free hypochlorous acid in certain electrolytic bleach solutions is explained by the use of salts of calcium or magnesium in the electrolyte, and by the insoluble form in which these metals are separated at the kathode. As free hypochlorous acid is of higher bleaching value than its salts, its determination *separately* by Jorre's method is requisite, when testing such solutions for active chlorine.

Dealing with the industrial preparation of bleaching solutions by electrolysis, the author decides in favour of cells having a large number of secondary electrodes, and thus capable of utilising currents of high E.M.F. A detailed description of the Kellner cell, with its "point" electrodes, is given. The chief disadvantage of this cell is its high cost, due to the platinum which it contains; and on this account attempts have been made by other inventors (notably Haas and Oettel) to utilise carbon for the electrodes. Carbon is, however, attacked to some extent by the oxygen of hypochlorites, and a loss of efficiency thus results. In time the author thinks some form of carbon may be produced, which will be more resistant in such solutions. The article closes with an unfavourable criticism of the original form of Hermite cell.

J. B. C. K.

REFERENCES.

1540. *Freezing-Point Methods in Dilute Solutions and the Theory of Solutions.* **M. Wildermann.** (Zeitschr. Phys. Chem. 32. pp. 288–302, Feb. 20, 1900. See 1900, Abstract No. 675.)—A controversial paper. The results of Dieterici (see 1898, Abstract No. 818) and the position taken up by him with regard to this subject are severely criticised. The work of Raoult (see 1899, Abstract No. 858) and of Loomis (see 1900, Abstract No. 884) is also referred to. T. H. P.

1541. *Solubility of Gases in Water.* **W. French** and **F. Ashworth.** (Chem. News, 81. p. 13, Jan. 12, 1900.)—The author describes a simple form of apparatus, constructed of two or three burettes, by means of which the solubilities of the more sparingly soluble gases may be demonstrated with considerable accuracy by class students. N. L.

1542. *Influence of Water on the Combustion of Carbon Monoxide. A Plea for Contact Action.* **G. Martin.** (Chem. News, 81. pp. 25–27, Jan. 19, 1900.)—A theoretical paper in which Dixon's views are criticised. Mainly of chemical interest. N. L.

1543. *Progress of Electro-chemistry.* **H. R. Kingman.** (West. Electn. 26. pp. 152–153, March 10, and 177–178, March 17, 1900. Paper read before the Chicago Electrical Association, March 2, 1900.)—The author gives brief summaries of the work of Arrhenius, van't Hoff, Nernst, and Ostwald, and points out the relation of this to modern theories of electro-chemical change. Under the head of chemical manufactures he describes at length the Le Sueur process for the production of alkalies and bleach, and less fully the Castner-Kellner and Solvay processes for manufacture of the same chemicals. Under the head of Electro-metallurgy details of the Hall process for aluminium production are given, and some space is devoted to methods of electro-galvanising. The closing section of the paper deals with primary and secondary batteries. J. B. C. K.

STEAM PLANT, GAS AND OIL ENGINES.

STEAM PLANT.

1544. *Multiple Cylinder Engines.* **E. Lefer.** (Écl. Électr. 23. pp. 60–61 April 14, 1900; Bulletin de la Société d'Encouragement, 5. (3) pp. 58–117, Jan., 1900.)—The author compares the advantages and disadvantages of expanding steam in more than one cylinder, as compared with expansion in a single cylinder. When steam engines were first employed on a practical scale to drive industrial works the system of expanding the steam in two cylinders was introduced, though the object to be obtained in so doing was not fully appreciated. As the engines in use at that time were beam engines, one of the main reasons put forward was that it gave a more regular turning effort than when a single cylinder was used. It seems, however, looking at the types of engines which followed these, that an effort was made to obtain a wide range of expansion without altering the existing imperfect means of steam distribution.

The author traces the various stages of development of the compound steam engine up to the time when modern research demonstrated its economy, but thinks that in spite of the labours of modern experimenters the information relating to this type of engine is not very complete. He then refers to the advocacy of quadruple and quintuple expansion by some engineers, based on the assumption that the more the difference of pressure, and consequently the fall of temperature, in each cylinder was reduced, the less became the internal condensation and the consumption of steam; experience, however, does not always bear this out, and usually expanding three times is considered sufficient. He refers to the uncertainty that existed as to the correct ratios of cylinder volumes, which to-day usually vary from 2·6 to 3 for the ratio of the intermediate to H.P. cylinder, and thinks that practice has had more to do with determining this ratio than theory.

He then passes on to examine the different methods of utilising the steam in order to give a minimum consumption per I.H.P. To do this he makes use of the same data that he has already employed in a former paper on single cylinder engines; but in order to establish a comparison between multiple cylinder engines and single cylinder engines, he assumes that the expansion of steam follows Mariotte's law, which is far from being the case in multiple cylinder engines. Under these conditions he calculates the steam consumption per I.H.P. per hour, assuming different values for (1) Ratio of cylinder volumes; (2) Cut off; (3) Initial pressure of steam in cylinder; and then compares under these conditions engines on the Woolf system and those with two or three cylinders.

Various tables are given in the paper read before the *Société d'Encouragement*, showing the influence of these several points. If the results for two-cylinder compound engines are examined it will be seen that a diminution of cylinder ratios corresponds (1) To an increase of power developed by the steam in the first cylinder; (2) To a corresponding diminution in the second cylinder; (3) To an increase of the total power developed by the two cylinders; (4) To an increase in the weight of steam condensed in the first cylinder; (5) To a diminution of the weight of steam condensed in the second cylinder ; (6) But the total amount of water condensed shows no diminution.

A closer investigation seems to show that cylinder ratios varying between two and four are best as regards utilisation of heat. A consideration of the influence of various points of cut-off shows that for a given cylinder ratio there is a point of cut-off corresponding to a minimum consumption of steam.

In the third part of the paper the author discusses a number of diagrams taken on multiple cylinder engines, and compares the results of this examination with his calculations. He concludes by stating that although it is true that by employing two or more cylinders to expand the steam in, the fall in temperature in each is reduced, and consequently the internal condensation should fall too ; yet, on the other hand, the cooling surface in contact with the steam is increased, so that what is gained by decreasing the range of temperature is more than counterbalanced by the increase of surface in contact with steam. It is from this cause that the steam consumption of a compound engine may be higher than that for a single cylinder engine. He considers that the loss from condensation is largely due to the difficulties of obtaining the best possible steam distribution with a single slide valve, and it is this that has led to the introduction of improved independent valves on single cylinder engines. L. S. R.

1545. *Ljungstrom's Crankless Engine.* (Engineer, 89. p. 362, April 6, 1900.) —This is a single acting rotary high speed steam engine. Four radial cylinders are fitted with pistons, the trunks of which are provided with wheels which roll round inside an elliptical path. Steam is supplied through a central valve which is stationary, the cylinders revolving round it. The cylinders obtain the steam from the supply port of the valve when the pistons move outwards, and exhaust through the exhaust port of the valve when the pistons move inwards. The turning force of the engine is obtained from the side-thrust given by the pistons when forced by the steam against the outward-going curves of the track. Results of tests made by R. L. Weighton, of Durham College of Science, Newcastle-on-Tyne, are appended. The engine, having four cylinders, 2¾ inches diameter × 1⅜-inch stroke, was tested as a high pressure non-condensing engine. The steam coming from the engine was actually condensed for measurement purposes, but no vacuum was formed. Under varying conditions of cut-off the consumption of water per B.H.P. hour varied between 40 and 50 lbs. ; the H.P. was varied from 4·63 at 70 lbs. pressure, cut off at ¼, and 1,616 r.p.m., to 18·09 at 180 lbs., cut off at ⅓, and 1,760 r.p.m. The engine ran satisfactorily, and the consumption of oil was low. L. S. R.

1546. *Present Position of the Steam Engine.* **R. H. Thurston.** (Mech. Eng. 5. pp. 476–480, April 7, and 550–554, April 21, 1900. Paper read before the American Society of Mechanical Engineers.)—The paper traces the progress in steam engine efficiency from the time of Watt to the present day. The losses in our best engines may be to-day taken as usually not far from 20 per cent. thermal and 10 per cent. dynamic. At the beginning of the century they were in Watt's best engines about 60 per cent. thermal and 15–20 per cent. dynamic. The progress of to-day is mainly an improvement of the thermodynamic efficiency by increasing the range of temperature worked through, and by improving the cycle in the direction of a nearer approximation to Carnot's ideal.

The author took part in an official trial of a Nordberg steam pumping engine, which was expected to exhibit an exceptional efficiency as a consequence of its unusually close approximation to the Carnot cycle. The mechanical arrangements of the engine and pumps are fully described in the paper. Thermodynamically the engine is specially interesting from the fact that the feed heating is done at increasing temperatures throughout, there being four heaters receiving steam from the various receivers. Trials were made with and without the heaters in operation. The duties without and with the heaters were 150,000,000 and 163,000,000 foot lbs. of work respectively per 1,000,000 B.Th.U. supplied. A. S.

1547. *Liquid Fuel.* **H. Guérin.** (Génie Civil, 37. pp. 22–25, May 12, and 36–39, May 19, 1900.)—This subject has recently come afresh before the French Society of Civil Engineers with special reference to the establishment of supply stations for ships of war. Evidence exists of the increased use of liquid fuel in British vessels trading to the Far East, the installation of a charging station at Suez having been authorised by the Egyptian Government, and for railway and other purposes in Russia, America, and other countries. The author refers to articles in vols. 34, 20, 24, 8, 21, 35, and 36 of the *Génie Civil*, and to a paper in the *Engineering and Mining Journal* of New York by H. Tweddle which describes the best methods of using this fuel and of which this article is to some extent a *résumé*. The best results have been obtained by the use of crude petroleum.

The proportions of carbon, hydrogen, and oxygen in various hydrocarbons and their calorific power (in calories per kg.) are given in the following table:—

	C.	H.	O.	Calorific Power.
Light petroleum oil—American	86·894	13·107	—	10,913
Refined	85·491	14·216	0·293	11,047
Petroleum spirit	80·583	15·101	4·316	11,086
Crude petroleum	83·012	13·889	3·099	11,094
Light oil from Baku	86·700	12·944	—	10,843
Petroleum from the Caucasus	84·906	11·636	—	10,328
Ozokerite from Boryslaw	83·510	14·440	—	11,163

To realise the theoretical calorific power and the highest temperature of combustion it is necessary to supply to the combustible the exact quantity of air furnishing the necessary amount of oxygen, and to have the most intimate possible contact between the air and the fuel. Consequently gaseous fuel offers the best conditions for obtaining the best result, liquid fuel the next, and powdered solid fuel the next in order, although in practice excess of air, deposits of soot and other causes prevent more than a moiety of the useful effect being realised, especially in the case of coal firing. The methods of using fuel in the liquid form are, however, the most simple of all, and hence the repeated efforts towards a more general introduction of this kind of fuel.

Various forms of injectors or "pulverisers" which have been from time to time proposed and introduced are enumerated by the author, and the effects of different forms of jets on the completeness of the pulverisation of the oil and its admixture with the air are discussed. The most suitable form of flame for a given furnace or process depends upon the quality of the oil and on the purpose to which the heat of combustion is to be applied.

Tweddle has found by experiment that in order to obtain the highest possible temperature from liquid fuel it is necessary to burn it in fire-brick combustion chambers of limited capacity, and that for evaporative effects an injector worked by steam is preferable to one using an air-jet which is more suitable for reheating, forge, and other furnaces of that class. The author introduced the use of petroleum fuel on the Oroya Railway in Peru in the year 1890, where experiments had to be conducted under unfavourable conditions. Starting from sea-level at Callao, the railway crosses the Andes at an altitude of 4,250 metres, with a total length of about 160 kilometres. The gradients and curves are consequently against the realisation of a high duty. Nevertheless, the consumption of oil was little over half that of coal for the same work, although the calorific power of the oil as compared with that of the coal was only as 1·4 is to 1.

The apparatus used on this railway is described in detail with illustrations of the burner, or pulveriser, and of the type of furnace employed.

The evaporative effect produced by firing boilers with American petroleum was in 1896 found by the Weyher and Richemund Company to be 12·5 lbs. of water per lb. of fuel; at the power station of the electric tramways of Los Angelos it was 12·89 lbs.; and in other experiments, with Borneo petroleum, 758 grammes of oil produced the same results per H.P. hour as 1,030 grammes of Newcastle coal. At the last Exhibition in Chicago the steam boilers, working at about 125 lbs. per square inch pressure of steam, gave with mineral oil fuel an evaporation of 14·25 lbs. of water per lb. of combustible as against 7 lbs. per lb. of coal. The theoretical evaporative power of carbon burning to carbon dioxide is 15 lbs. of water at boiling-point under atmospheric pressure.

In steamships it is necessary to use heavy oils igniting at 121° to 149° C. in order to guard against the risk of fire, these oils being quite safe even if a bar of red-hot iron be plunged into them. Experiments made by the French Government on the use of petroleum in torpedo-boats proved that it is too dangerous for use in such vessels.

Tweddle made experiments by firing cannon-balls and shells into a pile of casks containing benzene, with the result that the flame from the exploding shell frequently set fire to the benzene vapour. Practically the same effects were produced with kerosene and crude petroleum, but with oil igniting at 115° C. no flame was produced even under much more severe tests. If the oil employed has a sufficiently high point of ignition it offers greater security from fire than coal and much more than powdered fuel in bulk, both under the conditions of warfare and under ordinary conditions in which spontaneous combustion sometimes occurs.

The handling and storage of liquid fuel are also a much more easy matter than is the case with coal; the necessary appliances are fewer and more simple, and the minimum of labour is all that is required. There are also other minor advantages, not the least of which is the saving of space on board ship for storage of fuel.

In furnaces used in the industrial arts some of its advantages may be realised, where a high temperature and a pure flame are desired and when the price of coal is high. The author gives some illustrations of such furnaces, and, in particular, of one designed by Tweddle for the combustion of benzene.

F. J. R.

GAS AND OIL ENGINES.

1548. *Electrical Ignition for Gas Engines.* **P. P. Nungesser.** (Elect. World and Engineer, 35. pp. 510–511, April 7, 1900.)—Reliable electric igniters, that combine durability with simplicity of construction, have met with the greatest success in the hands of the average operator. Electrical igniting devices consist of two classes: primary and secondary. Primary igniters, by far the most largely used, are made in three forms: (1) The striking or "make and break" contact employs a movable point, operated by mechanism *outside* the cylinder to strike the stationary point, and can be adjusted to produce ignition at that part of the stroke which gives the highest efficiency with the given combustible mixture. (2) The rotary or wipe spark igniter, which has great wear in the sliding contacts and requires frequent attention to keep it in order. This form gives, with the same consumption of battery power, a much larger spark than the striking or make and break igniter. (3) The make and break *inside* igniter, which has the movable part attached to the piston, and separated from the insulated stationary rod by the forward motion of the piston, thereby igniting the mixture.

In the second class, known as jump spark electrical igniters, there is an insulated plug through which pass the wires from an induction or secondary coil to points in the combustion chamber, $\frac{1}{8}$ to $\frac{3}{16}$ inch apart. The spark passes through this air space when the primary or battery circuit is closed.

Experience, on automobile and yacht engines, has shown that a battery having $4\frac{1}{2}$ to 6 volts is required with low internal resistance to give 8 to 16 amperes. Waste of current is prevented by having the spark coils of suitable impedance, which may double the life of the battery. Instead of the old style long coils, a primary coil best suited for high speed engines, such as used on automobiles, should not exceed 6 inches in length overall, made of annealed Swedish iron, reannealed after cutting, in order to be magnetised and demagnetised rapidly. This shortens the time the circuit has to remain closed, and gives economy in battery power.

Spark coils must be thoroughly waterproof for good insulation. A dry battery is sometimes used for starting an engine where a dynamo or magneto-generator, driven by the engine, gives ignition until the speed is reduced. The high speed necessary for these generators produces considerable wear of moving parts.

The writer considers a good portable closed circuit battery, perfectly sealed or water-tight, without paraffin oil, is not only more economical than the dry battery and dynamo combination, but it requires less care in the rough usage of engines on carriages and boats. W. R.

AUTOMOBILISM.

1549. *Renaux Motor Tricycle.* (Automotor Journal, 4. pp. 379–381, May, 1900.)—A full description, with illustrations from La France Automobile, of a motor tricycle in which the differential gearing is incorporated into the motor itself and in which the motor-shaft is practically in line with the transmission gear and with the driving-wheel axles. The motor is arranged to form a portion of the framework of the cycle and it is fitted with roller-bearings throughout (including the crank-pin). The differential gear is formed by a planet pinion-wheel, which is mounted in bearings in the crank-pin and which meshes with (and drives) pinion wheels upon the two driving axles. The crank-pin is secured to two fly-wheels which run independently from, and concentrically about, the driving axles. Rack (internal) and pinion transmission gearing are used for reducing the speed of the driving-wheels, relatively to the motor-speed. The motor has a single cylinder, 90 mm. bore × 90 mm. stroke, and develops about $3\frac{3}{4}$ H.P. at 1,400 r.p.m. The weight of the tricycle is about 140 kg. A Longuemare carburettor is used and a high tension, variably timed, ignition device is employed. A. G. N.

1550. *Stanley Steam Carriage.* (Automotor Journal, 4. pp. 387–390, May, 1900.)—A description of the lighter type of American steam carriages. The boiler is of copper with steel ends and is 18 inches high; 298 $\frac{7}{16}$-inch tubes, $\frac{1}{16}$-inch thick, are expanded into the boiler ends. Piano steel wire is wound round the copper boiler and lagging is provided outside this wire. The furnace consists of 2,500 jets and is fed with petroleum at a pressure of about 85 lbs. per square inch; the petroleum feed is controlled by an automatic valve actuated by the steam pressure and is heated, before reaching the burners, by being passed through a pipe which is carried through two of the boiler-tubes. The working pressure is 160 lbs. per square inch; at this pressure the steam cuts off the fuel supply to the furnace. The engine is light, is fitted with ball-bearings throughout, has two double acting cylinders (2½-inch bore by 3½-inch stroke) and develops about 4 H.P. The transmission gear consists of a single (⅜-inch) chain drive, from the engine shaft to the differential gear on the "live" back axle, and provides for a car-speed of 10 miles per hour when the engine is running at 400 r.p.m. Water is fed to the boiler by a force-pump, driven by the engine. The driver regulates the water-feed by a bye-pass on the pump, in accordance with the showing of a water-gauge. The car weighs about 4½ cwt. Drawings are given of a larger vehicle, of the same type, which was previously described in Abstract No. 563 (1900). A. G. N.

REFERENCES.

1551. *Feed-water Heaters.* (Amer. Electn. 12. pp. 236–238, May, 1900.)—A notice of some forms of feed-water heaters constructed in America, of the U-tube, coil and straight tube kinds, some having the steam and some the water inside the tubes, This article is in continuation of others which have appeared in the January and February issues of the same journal, and contains good descriptions and illustrations of the Stilwell, Hardwick, Otis, Devries-Berryman, Kelley-Berryman, Robertson, American, Goubert, and Wheeler heaters. F. J. R.

1552. *Parsons Steam Turbine.* (Amer. Electn. 12. pp. 124–127, March, 1900. Also Mech. Eng. 5. pp. 409–411, March 24, 1900.)—An article, illustrated by drawings and process blocks, describing this turbine. Steam consumption curves for a 500-H.P. set are also given.

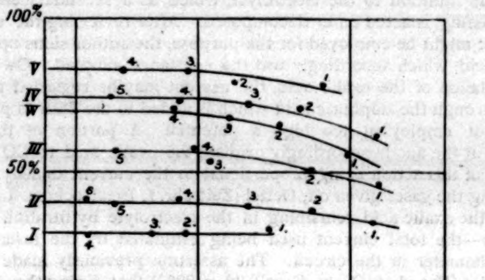
GENERAL ELECTRICAL ENGINEERING.

1553. *Estimating the True Surface of Accumulator Plates.* **K. Norden.** (Zeitschr. Elektrochem. 6. pp. 397–403, Feb. 1, 1900.)—Since Planté employed his first accumulators of rolled-up lead sheets, instead of flat plates, the direction in which the perfection of the accumulator, as regards its capacity, could be approached has been clearly indicated. This lies in increasing the ratio of the true surface of the plate to its apparent surface—the "surface-development," as it has been called by A. Wilke. The apparent surface is, of course, obtained by simply measuring the depth and breadth of the plates. The problem is to ascertain the true surface which at the same time with any given current enables the true current density to be obtained. There is no difficulty in regard to ribbed plates of the Tudor or Majert type. The true surface can be directly measured, and is from eight to nine times the apparent surface in the former case and about fourteen times the apparent surface in the latter. In the case of pasted plates no such method can be employed, and the present method has been devised to overcome the difficulties of the problem in this case. The main idea of the process is to employ some substance as an addition to the electrolyte, which, as a secondary effect of the current passing, is acted on or decomposed. After reviewing the various reagents that might be employed for the purpose, the author sums up in favour of oxalic acid, which accordingly was the substance adopted. Owing to the high resistance of the oxalic acid, the current may be regarded as entirely passing through the sulphuric acid which is added to the bath to prevent the necessity of employing too high a potential. A portion of the oxygen developed at the anode accordingly oxidises the oxalic acid to CO and CO_2, the extent of this action being proportional to the current density. Instead of analysing the gases given off, Oettel (Zeitschr. f. Elektrochem. 1. p. 90) has estimated the oxalic acid remaining in the electrolyte by titration with permanganate—the total current used being estimated by the insertion of a copper voltameter in the circuit. The assertion previously made by Avery and B. Dales (Ber. d. d. Chem. Gesell. 32. p. 2233), that during the electrolysis of oxalic acid glykolic acid is produced by reduction at the kathode, was found to be only true under certain circumstances. Previous researches have established that the electrolysis of oxalic acid, in addition to being dependent on the surface of the anode and the current, increases with the temperature and the degree of concentration. The process, as Oettel has pointed out, must therefore not be continued too long. To work to a particular degree of concentration, owing to the difficulty and complication in so doing, is not recommended. The experiments were performed on an incandescent lamp circuit of 110 volts, a delicate adjustable resistance being employed to keep the current absolutely constant. In the experimental cell there was employed as electrolyte 200 c.c. of $N/4$ oxalic acid solution, to which was added sulphuric acid to the extent of 50 gm. per litre. As the temperature had to be kept constant the cell was immersed in a basin of water, by which means the temperature was throughout kept very nearly at 18° C. The following table gives the results of one series of experiments, using

200 c.c. of oxalic acid (0·2500 N = 3·150 gm.), and anode surface of 18 sq. cm. :—

Experiment.	Duration of Experiment—Min.	Current Amperes.	E.M.F. of Bath Volts.	Increment of Copper Voltameter—Grammes	Oxalic Acid Oxidised—Grammes.	Gms. Cu. Equivalent to Acid Oxidised.	Decomposition Value—per cent.	Decomposition Value Obtained from Curve for $t = 0$—per cent.	Mean Anode Current Density for the Series.
1	60	2·05	4·0	2·4276	1·435	0·725	29·9	28·5	11·43
2	40	2·04	4·22	1·6070	0·920	0·464	28·9		
3	30	2·06	4·0–4·13	1·2210	0·695	0·351	28·7		
4	12	2·08	3·87–3·76	0·4946	0·272	0·137	27·8		

In this table t is the duration of the experiment. In order to find the percentage decomposition (copper equivalent to acid oxidised, copper equivalent to total coulombs) at the moment of closing the circuit, *i.e.*, when $t = 0$, the author plots the percentage decomposition against the equivalent of copper for each series (as shown in the figure), and produces the curves so obtained back to the axis.



To obtain from the above table the comparative results a series of comparable experiments with an anode of *known* surface were necessary. These were carried out under conditions similar to those under which the above table was obtained with a lead plate of 0·333 sq. dcm., folded up to resemble a ribbed plate of 0·222 sq. dcm. apparent surface, and the results give rise to curve W in the diagram.

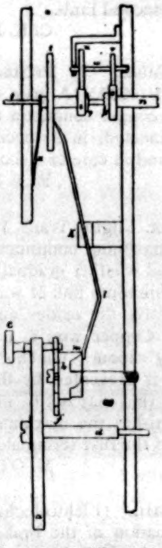
Estimates made from the last series of experiments of the experimental error involved in the method show that it does not exceed 6·6 per cent.

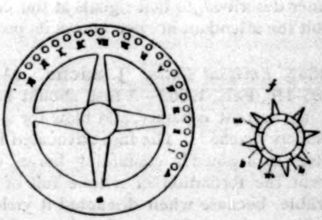
R. N. L.

1554. *Sliding-scale Electricity Meters.* **Kusminsky.** (Zeitschr. Elektrotechn., Wien, 18. pp. 158–159; Discussion, pp. 159–160, March 25, 1900.)—

The first of these meters discussed is that of L. Zahn. This is of the Aron-type, and has a mechanical clutch controlled by a clock, which effects the throwing into and out of gear of mechanism for varying the number of revolutions made by the counting train.

On the meter case is mounted a second case, which contains an independent clockwork movement which, in twenty-four hours, rotates a wheel *a* through one revolution. This wheel is provided around one-half with hour marks XII to I, and has holes *b* to receive pins *c*. Near this wheel is freely mounted a wheel, *f*, having arms, *g*, and rigidly secured to a cam-wheel having four projections, *m*, and four depressions, *h*. If a pin be inserted into one of the holes, *b*, in the rotation of the wheel, *a*, this pin strikes against an arm, *g*, of the wheel, *f*, and turns it through one division, together with the cam-wheel, which causes a double-armed lever, *l*, to oscillate and throw over a clutch, whereby a different counting train is thrown into action. By placing the pin, *c*, in one or other of the holes, the time at which this change takes place can be varied as desired.





An instrument is constructed by the General Electric Company, having two meters, of which one runs continuously and registers the amount to be paid, whilst the other is only thrown into gear at predetermined times and registers the excess charge.

The Union-Elektricitäts-Gesellschaft has a meter in which the brake-magnet exerts a greater retarding force during the day than in the evening.

In the discussion the fact was referred to that the movable coil of a Deprez-d'Arsonval galvanometer will act in a similar manner to a condenser if the moment of inertia of the movable coil and the periodicity of the alternate-current are very low and the strength of the field very high.

C. K. F.

1555. *Rimington Maximum Demand Indicator.* (Electrician, 44. pp. 921–922, April 20, 1900.)—This indicator is designed to be applied to electrolytic meters of the Bastian type [see The Electrician, 41. pp. 104, 112, 138] and consists of a U-tube, the first limb of which is connected by a flexible tube to a glass tube sealed into the top of the electrolytic meter in such a way that the evolved gases are carried off through this tube. The second limb is provided at its upper end with a porous plug which prevents violent movement of the liquid contained in the lower part of the U-tube. Near the upper end of the first limb is another porous plug. The rate at which the gases are evolved (varying as the current) determines the pressure of the gas in this part of the tube, and all the liquid raised thereby into the second limb overflows into a vertical tube flexibly connected thereto. The maximum current passed through the meter, therefore, is indicated by the height of the liquid in the vertical tube above mentioned. The time lag in the working of the indicator can be controlled by the plug at the top of the second limb.

C. K. F.

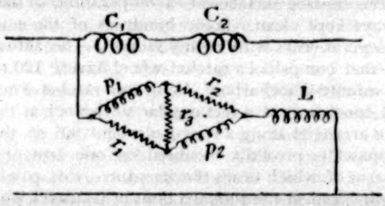
1556. *Fault-Detector for High-Pressure Concentric Cables.* **F. Probst.** (Zeitschr. Elektrotechn., Wien, 18. pp. 161–165, April 1, 1900.)—A pair of small section insulated wires are laid on with the outside copper conductor of a single-phase concentric cable. These wires are connected, in a special manner described, to bell signals at the central station, and in case of a short circuit the attendant at once knows its position. E. K. S.

1557. *Enclosed Fuses.* **J. Sachs.** (Amer. Inst. Elect. Engin., Trans. 17. pp. 85–116, Feb., 1900.)—A fuse should have a definite maximum continuous running current capacity, and blow for a definite overload whether gradually or quickly reached. The fuse advocated has a zinc or aluminium link of wire or strip in a powder containing borax, which will dissolve the oxides, and prevent the formation of a tube full of molten wire. Copper wire is not desirable, because when disrupted it yields a conducting vapour. On short-circuiting a fuse with long break an objectionable arc is prevented by the sudden disrupting of the fuse, but with slow overloading this may not be the case. An inductance in series with a large fuse diminishes the maximum rush of current but increases the potential of break across the fuse terminals.

M. O'G.

1558. *Electrical Absorption Dynamometer.* **A. Grau.** (Elektrotechn. Zeitschr. 21. pp. 265–267, April 5, 1900.)—The determination of the brake-power of a motor by means of any ordinary form of mechanical absorption dynamometer does not admit—especially in the case of small motors—of any high degree of accuracy. The friction between the brake and pulley is liable to undergo constant changes, and seriously interferes with the accuracy of the measurement. The author describes an electrical dynamometer which is capable of giving excellent results. It consists of a circular disc of copper mounted on the shaft of the motor, and placed between the poles of an electromagnet attached to a long lever which is mounted on knife-edges and carries a sliding-weight. The principle of the arrangement is identical with that used in several well-known supply meters for providing the resisting torque. By sliding the counter-weight along the lever, the pull on the magnet due to eddy-currents in the brake disc may be balanced. This pull may be maintained absolutely constant by means of a continuously variable resistance in the exciting circuit of the electromagnet. The author states that in the instrument used by himself a displacement of the sliding-weight of less than 1 mm. was sufficient to upset the balance. The results of some brake tests on a 1 H.P. motor are given, and show in a striking manner the high degree of accuracy attainable by means of this method. A. H.

1559. *Alternate Current Meters with Rotary Field.* (Elekt. Runds. 17. pp. 131–132, April 1, 1900.)—In meters of this description two adjustments are necessary: first, a phase-adjustment for the shunt circuit, whereby the field of this circuit is brought exactly into quadrature with the impressed P.D.; and secondly, an adjustment for varying the field intensity so as to enable the instrument to be made direct reading. Altering one of these adjustments generally upsets the other, so that the final adjustment can only be obtained satisfactorily after a good deal of trouble. In order to avoid this difficulty Siemens and Halske have recently introduced the method of connection shown in the accompanying diagram, in which C_1 and C_2 are the main or current coils, and p_1, p_2 the pressure coils, producing a field which is in quadrature with the main field. The phase-adjustment is obtained by varying the non-inductive resistance r_3, and the intensity-adjustment by varying simultaneously the two equal resistances r_1 and r_2; L being a reactance-coil which is joined in series with the Wheatstone-bridge arrangement of the shunt circuit. A. H.



1560. *Aluminium Electrical Conductors.* **F. C. Perkins.** (West. Electn. 26. pp. 146–147, March 10, 1900.)—This paper deals with the possibilities of aluminium for use in electrical work. Figures relating to the physical and mechanical properties of aluminium are given, from which it would appear that for a given conductivity the weight of an aluminium conductor may be taken as 50 per cent. of that of copper. A description is given of the plant which has recently been erected by the Pittsburg Reduction Company and the Niagara Falls Power and Manufacturing Company to cope with the expected demand for aluminium in electrical construction, and which includes four 1,000-H.P. continuous current Westinghouse generators and turbines, and the erection of two new turbines by the Niagara Falls Company.

Instances are cited of the use in practical work of aluminium conductors in railway feeders, power transmission lines, and electric elevated railroads, and the relative merits of copper and aluminium for conductors generally are discussed. The paper concludes with some statements respecting the electric properties of the two metals when used in electric circuits. E. C. S.

1561. *Electrical Time Service.* **F. Hope-Jones.** (Inst. Elect. Engin., Journ. 29. pp. 119–138; Discussion, pp. 141–153, Jan.; and pp. 286–288, March, 1900.)—The author gives a short *résumé* of the various types of electric clocks which have been made, and finally sums up in favour of a system in which a controlling or master-clock sends out frequent impulses into the line to directly propel the hands of large numbers of indicator dials. He then proceeds to describe a system patented by himself and G. B. Bowell, which comprises special forms of controlling clock and indicator dial. The controlling clock consists of a clockwork train, which is controlled by an escapement, and in which the main-spring is replaced by a ratchet-wheel acted upon by a pawl on a weighted lever. This weighted lever has an arm forming a bridge-piece which, as the weighted lever approaches its lowest position, short-circuits two contacts mounted on a spring-controlled pivoted lever, forming the armature of an electromagnet in the line circuit. The armature lever is then attracted, the weight raised, and the circuit again broken. By these means the entire energy required for keeping the pendulum swinging is mechanically transmitted through the contact surfaces at each operation, so that these contact-surfaces are always kept clean. Some hundreds of these instruments have been in use for several years without any failure. The actuating mechanism of the indicator dial comprises a ratchet-wheel having 120 rectangular teeth, mounted on the minute-wheel arbor. With this ratchet-wheel there engages a retaining pawl consisting of a rectangular steel block at the extremity of a long pivoted arm arranged along a chord of about 90° on the ratchet-wheel. The propulsion-pawl is pivotally mounted on one arm of a double-armed lever, the other arm of which bears the armature; this pawl acts at an angle of 135° to the radius, and, at the forward limit of its travel, where it is normally held by a flat spring, it abuts against one stop, and at the backward limit of its travel it abuts against a second stop. A modified form is shown applied to a turret clock and actuated through a relay. The paper comprises a bibliography of the subject.

In the discussion **A. J. Lund** advocated the use of synchronised clocks on the ground that, if the line broke down, the clocks would still go on unsynchronised.

C. Puttkammer described the Normal Time Company's system, wherein the clocks are successively regulated from a central timepiece, and are wound up electrically, either by a strong current (Aron system), or by a weak current (Normal Time system). There is a registering contrivance on the central time-piece whereby a mark is registered on a running strip of paper so as to enable the deviation of each clock to be determined.

Hope-Jones, in his reply, stated that, in the controlling clock, there was a maintaining spring connecting the ratchet-disc and the train so that the going pressure is never off the escapement. C. K. F.

1562. *Electric Annealing of Armour-plate.* **C. J. Dougherty.** (Eng. Club Phil., Proc. 17. pp. 12–22; Discussion, pp. 22–23, Feb., 1900.)—The author begins by explaining the disadvantages of having to bore the holes in armour-plates before hardening them by the Harvey or Krupp processes, and mentions sundry abortive attempts which have been made to obviate the difficulty. He then proceeds to explain the method devised by the Thomson Electric Welding Company, of Lynn, Mass., and the apparatus utilised for the purpose of locally softening the steel by means of the intense heat of a very heavy current. The current is generated at 300 volts, and the maximum employed is 100 amperes. It is transformed down to from 2·5 to 2·8 volts, and at the maximum 10,000 amperes are passed. The current is introduced by special water-cooled copper contacts and a current density of as much as 40,000 amperes per square inch is employed where these touch the surface of the plate, but so effective is the water-cooling that the leads do not suffer at all. The current has to be turned on gradually by means of a resistance, and must not be switched off suddenly or the softening is not effected. The operation takes from fifteen to twenty minutes. Illustrations and diagrams are given. J. L. F. V.

1563. *Electricity applied to Agriculture.* **P. Renaud.** (Électricien, 19. pp. 259–264, April 28; 281–285, May 5; 311–316, May 19; 326–332, May 26, 1900. Lecture delivered before the Société Industrielle de l'Est.)—The author insists on the absolute necessity of mechanical power for certain agricultural operations, and states that the direct application of steam power is too expensive and cumbersome. To break up 2½ acres of land to a depth of 26 inches (for vine-culture) by steam power costs £15, while by electric power the cost, inclusive of capital charges, amounts to only £7·2; the portable steam machinery weighs twelve tons, the electrical machinery four to five tons. After briefly outlining the history of the subject, and the different methods of working that are available, and referring to certain apparatus of which figures are given, the author describes the systems of F. Prat and the Eckert firm, in which the plough is hauled by an electric windlass, working in one direction, and returning idle. In the Brutschke system the plough works in both directions, the windlass being reversed at the completion of each furrow; the bight of the cable is carried round a pulley mounted on a four-wheeled carriage, the wheels of which are flanged to grip the soil, while an anchor with four blades provides additional resistance to the pull of the cable. When the plough is travelling towards the windlass, the pulley, rotated by the slack cable, is geared to a mechanism which raises the anchor and moves the carriage forward a set distance; the anchor is driven into the ground again by the reversal of the motion of the pulley when the plough starts on the return journey. At Ben-Sala, in Algeria, where the ground has to be worked between full-grown vines, an electric windlass is used at each end of the field, and the plough, instead of being double-ended, is turned round at the end of each furrow.

The Dollberg, Förster, and Siemens systems are critically described, with illustrations; references are given to more detailed descriptions. In the Förster system, with two windlasses, half the copper in the electrical circuit is saved by running a single cable to each windlass and utilising the steel haulage rope to complete the circuit. A table of results is given, from which it is seen that the best performance was obtained from the Siemens system: the efficiency was 66 per cent., with 16·5 H.P. at the ploughshares. The surface worked over in one hour without stoppage, ploughing 1 foot deep, was about one acre; as the stops aggregated 20 per cent. of the whole time, the net area worked per hour was about three-quarters of an acre. The applications of electricity to the transport of materials, threshing-machines, forage-compressors, chaffcutters, and sheep-shearing, are briefly touched upon, and the paper is concluded with a *résumé* of the many advantages derived from the use of electricity in agriculture. A. H. A.

1564. *Electric Riveting Machinery.* **F. v. Kodolitsch.** (Cassier, 18. pp. 71–74, May, 1900.)—The author has been experimenting on electric riveting machines, and has succeeded in bringing out two types capable of superseding hydraulic and pneumatic systems. He demonstrates that the initial capital outlay is far less for an electric system than for either an hydraulic or pneumatic installation, while the cost of up-keep is less. As regards the quality of work done, there is no difference, but the output of the electric system is considerably superior. The machine described by the author has closed, for weeks and weeks, 1,500 rivets per day of ten hours, requiring the attendance of only three men and a boy. In the machine there is one heavy disc which is always rotating. This disc may at any moment be made an electromagnetic coupling, by which a second disc keyed on to a screw-spindle may be rotated. The screw-spindle moves a large nut at the end of a toggle-joint, which raises and lowers the die for making the rivet-head. There is an automatic cut-out arrangement by means of which the two discs may be disconnected before the end of the travel of the nut. The energy of the second disc is then utilised to finish the rivet. The screw-spindle is four-threaded, the pressure of fifty tons put on the rivet-head is ample to make the machine reverse automatically; that is, after the rivet-head is closed the nut returns again to its original position to be ready for the next stroke. It is indifferent whether two, three, or four thicknesses of the plate be put between the dies, and no adjustment is necessary for different thicknesses. A. S.

1565. *Epicycloidal Method of Loading Moving Platforms.* (Street Rly. Journ. 16. p. 326, April, 1900. From the Zeitschrift des Vereins Deutscher Eisenbahnverwaltungen.)—This is an illustrated description of an arrangement devised by Vietor, whereby passengers can be conveyed automatically to a continuously moving platform, or a moving railway train, without the necessity of stepping from a stationary to a quickly moving part. The principle of the arrangement is as follows: The fixed platform is a circular disc; outside and concentric with the platform, but some distance away from it, is the circular track of the moving platform or railway train. Between the fixed disc and the moving track outside are smaller discs, the diameters of which are equal to the space between the fixed disc and the moving ring. These small discs practically roll along the circumference of the fixed disc, receiving their motion from the moving outer ring, and serve as the actual conveyers of the passengers. Some particulars of the construction and sizes are given. The advantages claimed by the inventor are: Low cost of construction and operation; small weight of rolling stock and equal division of load; no waiting for trains, or stoppage of them, at stations; absence of signals; a saving of rails and rolling stock on account of the uniformity of traffic; absence of noise, and convenience to passengers. It is proposed to show the method in operation at the Paris Exhibition. E. D. P.

REFERENCES.

1566. *Edinburgh Cable Tramways.* (Tram. Rly. World, 9. pp. 89–108, March, 1900.)—A very complete description of this system of cable tramways, with drawings showing in detail the construction of the track, conduit, &c., and photographs of machinery in the power houses.

1567. *High-Tension Switches, &c.* **Vedovelli.** (Soc. Int. Élect., Bull. 17. pp. 107–120, Feb., 1900.)—Description of high-tension switches, oil-fuses, horned lightning arresters, &c.

1568. *Electric Fans.* (Elect. Rev. N.Y. 36. pp. 159–168, Feb. 14, and 185–188, Feb. 21, 1900.)—Articles containing about fifty photographs of different types and arrangements of fans and motors as made in America.

GENERATORS, MOTORS, AND TRANSFORMERS.

1569. *Siemens and Halske Three-phase Generating Set at the Paris Exhibition.* (Elektrotechn. Zeitschr. 21. pp. 344–346, May 3, 1900.)—The machine is direct-coupled to a Borsig vertical engine, and the full load output is 2,000 kw. at 2,200 volts, 50 periods at 83·5 r.p.m. The poles are laminated; the field-magnet system forms the flywheel of the engine, and is mounted on a separate shaft with two bearings. The field copper is wound on edge, and its cross-section is 4 × 23 mm. Cross-sections are given, showing the construction of the armature and the cast-iron ring, &c. The armature conductors have a cross-section of 7 × 44 mm., and are arranged in 648 slots, each 13 × 55 mm., lined with micanite. The exciter is mounted direct on the alternator shaft; it is an eight-pole machine, and gives 45 kw. at 210 volts. E. K. S.

1570. *Lahmeyer Combined Three-phase and Continuous Current Set at the Paris Exhibition.* (Elektrotechn. Zeitschr. 21. p. 366 and pp. 367–368, May 10, 1900.)—The two machines are mounted at each end of a Nürnberg compound vertical engine and run at 94 r.p.m. The three-phase machine has an output of 1,000 kw. at 5,000 volts and 50 periods, the number of poles being 64, mounted on a double-armed flywheel. The continuous-current machine has twelve poles, and gives 350 kw. at 550 volts. Each machine is mounted on a separate shaft with outer bearings, and the rotating parts form the flywheel of the engine. The alternator has its own exciter, coupled direct. Six drawings are given, showing the construction of the machines. E. K. S.

1571. *Maximum Economy in Dynamo Construction.* **Mélotte.** (Assoc. Ing. Él. Liège, Bull. 11. pp. 85–109, April 20, 1900.)—The author assumes a fixed total flux, and output and efficiency, and then shows how the cost varies as the induction in the different parts of the magnetic circuit is varied. Curves are given, showing the cost of copper and iron in each part, and also the total. The cost of labour and general charges are allowed for in the price of materials. The author assumes as sufficiently true for the purpose that the weight of copper on the magnets varies as the square of the ampere turns, and inversely as the induction, and the weight of iron varies as the induction. He shows that if the relative price of copper and iron varies, the point of minimum total cost does not vary very much, and that the total flux may be varied between wide limits without affecting the point of minimum cost to any great extent. R. B. R.

1572. *Rheostatic, Double Commutator and Multivoltage Regulation of Motors.* **A. D. Adams.** (Amer. Electn. 12. pp. 208–211, May, 1900.)—Where only two speeds are required, the motor armature may be double-wound, the two windings being similar and used in series or parallel. For three speeds the two windings are unlike, and used either one singly, or the two in series. If three generators are used, giving respectively 40, 80, and 100 volts, arranged on a four-wire system, six different pressures of supply can be obtained. R. B. R.

1573. *Regulation of Motors by Varying Impressed and Countei E.M.F.'s.* **L. B. Mather.** (Amer. Electn. 12. pp. 211–213, May, 1900.)—The author describes five different systems. The Leonard system, in which an auxiliary motor-dynamo supplies current to the industrial motor. The speed control is good, but the cost is more than three times that of an ordinary motor. In another system, which is practically a modification of Leonard's, the same motor-dynamo is used, but the dynamo armature is connected to the supply circuit in series with the industrial motor armature, and opposing the supply E.M.F. In this case the motor-dynamo need not be quite so large. Equivalent results can be obtained by a motor three or four times the ordinary size arranged for regulation by varying the strength of its field magnet. The motor is compound wound, the main being in four coils which can be coupled in eight different ways by a controller. Another method is a six-wire system with five equalising dynamos or motors, with their shafts rigidly coupled, connected across the outer wires. For a 250-volt generator these equalising machines would be arranged in the following order : 50 volts, 25, 100, 50, 25. In this way any voltage may be obtained from 25 to 250, advancing by steps of 25 volts. All the equalising machines have the same output in watts, so that their current-carrying capacities differ. Some of the motors may be arranged to start on one of the 25-volt circuits, and some on the other, giving a better distribution of power on the circuit wires than there would be if there were no duplicate voltages. In the fifth system the equalising machines are replaced by 125 cells. In this system, of course, a much finer gradation of speed may be obtained by the use of a sufficient number of circuit wires. R. B. R.

1574. *Regulation of Motors Driving Printing Presses.* **T. a'Becket.** (Amer. Electn. 12. pp. 213–214, May, 1900.)—In driving printing presses the motor is usually required to run at a fixed speed, but occasionally it must run for a short period at a very slow speed during the "making ready" of the formes, and it must start without shock, under load. A special form of multi-contact resistance switch is useful for this. The first step puts one coil of resistance in parallel with the armature of a shunt motor, and the rest in series with the armature ; the next steps reduce the resistance in series, and increase it in parallel, till it is all in parallel, and then cut it out altogether. In another method the motor is compound, with four shunt coils in parallel. The first step of the switch puts in the series coil, and the four shunt coils in parallel. The succeeding steps first cut out the series coil, and then three of the shunt coils one by one. A combination of these two methods would give an ideal method of speed control for a printing press, when it is desirable to run at any one of several regular speeds not far apart, depending on the character of the printing to be done. R. B. R.

1575. *Controlling Frequency of Inverted Rotaries.* (Elect. World and Engineer, 35. pp. 507–509, April 7, 1900.)—By an inverted rotary converter is meant one used for transforming continuous into polyphase currents. Cases in which such inverted converters are used occur when it is more economical to supply a limited alternating-current service from a large continuous-current central station than to put down a special alternating-current plant for the purpose. When a rotary converter is used in the ordinary way, absorbing power from alternating-current mains and delivering continuous current, its speed is fixed by the frequency of the alternating current, the rotation being a synchronous one. But the speed of an inverted rotary is no longer controlled in this way: it is now running as a shunt-wound motor, and its speed will depend on the field intensity. If the currents on the polyphase side lag behind the E.M.F., the field may be greatly weakened, and the speed may rise to a dangerous extent. Similarly, a drop of speed may result from leading currents due to capacity in the mains or some other cause. In order to prevent such fluctuations in speed, and avoid the risk of speeds exceeding the safe limit, a very ingenious arrangement has been devised by B. G. Lamme, and has been applied in several instances by the Westinghouse Company. It consists in separately exciting the converters by means of a shunt-wound machine, whose armature is mounted on the converter shaft, and which is normally worked well below the bend in the magnetisation curve, so as to be extremely sensitive to very small changes in the speed. Any tendency towards an increase of speed is immediately checked by a very rapid rise in the P.D. of the exciter and consequent increase in the exciting current of the converter. A similar action in the opposite direction takes place when the speed tends to decrease. The arrangement has been found to give thoroughly satisfactory results. A. H.

1576. *Rotary Converters.* **H. S. Meyer.** (Elektrotechn. Zeitschr. 21. pp. 267–269, April 5, 1900. Translated in El. Eng. 25. pp. 618–620, May 4, 1900.) —The author briefly discusses the uses of rotary converters, and considers the various methods of excitation. The shunt winding is suitable where special arrangements are provided for regulating the P.D. at the ends of the various feeders on the continuous-current side. More commonly, however, the compound winding is used, by means of which an increase of the terminal P.D. may be obtained with an increase of load. This effect is brought about by the varying phase-displacement of the current relatively to the P.D. With light loads the current should be a lagging one, and with heavy loads a leading one. Between the converter terminals and the three-phase supply mains are inserted suitable choking coils, by the action of which a leading current causes a rise of P.D. across the converter terminals, while a lagging current causes a fall of P.D. Frequently the line itself has a sufficient amount of inductance to provide the necessary regulation, and then the choking coils may be dispensed with. It is to be noted that an increase in the excitation *per se* is unable to cause any change in the P.D., for the ratio of the continuous to the alternating P.D. is perfectly definite, and, though slightly variable with the load, is independent of the excitation. A third method of excitation consists in omitting the field winding entirely, so that the excitation is furnished by the armature current. On account of the extremely heavy wattless currents, and consequent low power-factor, this form of converter can hardly be expected to find any application in practice, except in cases where cheapness of construction is of paramount importance. The author finally deals with *inverted* rotaries (see preceding Abstract). In order to prevent racing, these machines should be over-excited and furnished with centrifugal regulators for cutting off the supply of current when the speed exceeds a certain limit; or the device described in the preceding Abstract may be used. A. H.

REFERENCE.

1577. *Double-Wound Armatures.* **A. D. Adams.** (Amer. Electn. 12. pp. 121–122, March, 1900.)—The author describes different kinds of double-wound armatures, and discusses their various uses. A. H. A.

ELECTRICAL DISTRIBUTION, TRACTION AND LIGHTING.

ELECTRICAL DISTRIBUTION.

1578. *Long-distance Transmission.* **L. Bell.** (Elect. Rev. N.Y. 36. p. 227, March 7, 1900.)—The limit in power transmission is, broadly speaking, indeterminate, for the distance practicable is a function of the price of fuel, and the voltage is in the main a function of climate. The necessary combinations for a successful trial are—a good market, a very high price of coal, and a climate dry enough to make insulation easy. Mexico or some portion of South America seems to be the place where we must look for pioneering work in this direction. The author points out that the present upper limit of high voltage seems to be set by the tendency of the air to fail as a dielectric. So far as the transformers are concerned the splendid insulating properties of oil have not been put seriously to the test by even the highest experimental voltages. In a dry climate one could safely go to 50,000 volts under existing conditions, and the author then imagines a typical case of the transmission from water-power of 1,000 H.P. over a distance of 200 miles at a voltage of 50,000 and a loss of 10 per cent. After computing the cost of copper, poles, plant, &c., he finds that a sale of 1,000 H.P. at 100 dollars per H.P. year would pay interest, and also provide a liberal sinking fund. This price is less than the cost of producing power in units of moderate capacity even in places where coal is no more than five or six dollars per ton. With coal at a higher price, electrical power transmitted even to so great a distance could cut under the cost of steam power and secure a paying market. W. G. R.

1579. *Importance of Wave-form in Three-phase Working.* **O. S. Bragstad.** (Elektrotechn. Zeitschr. 21. pp. 252–254, March 29, 1900.)—This is an important paper dealing with the effect of harmonics in three-phase working. If i_1, i_2, and i_3 stand for the instantaneous values of the current in the three-line conductors, we may write—

$$i_1 = \sum_{n=1}^{n=\infty} (A_1 \sin npt + B_1 \cos npt),$$

$$i_2 = \sum_{n=1}^{n=\infty} (A_2 \sin n\left(pt + \frac{2\pi}{3}\right) + B_2 \cos n\left(pt + \frac{2\pi}{3}\right) \Big\}$$

$$i_3 = \sum_{n=1}^{n=\infty} \Big\{ A_3 \sin n\left(pt + \frac{4\pi}{3}\right) + B_3 \cos n\left(pt + \frac{4\pi}{3}\right) \Big\}$$

On account of symmetry, $A_1 = A_2 = A_3$, and $B_1 = B_2 = B_3$. Further, we must always have $i_1 + i_2 + i_3 = 0$. From these conditions it follows that n must satisfy the equation $\cos n\frac{2\pi}{3} = -\frac{1}{2}$, and that consequently the possible values for n are 1, 2, 4, 5, 7, 8, 10, 11. . . . *In other words, in a three-phase system of currents, all harmonics whose frequencies are multiples of the fundamental frequency divisible by three are excluded.* Next, if there is symmetry of positive and negative half-waves, all the even harmonics are excluded. In this case the only possible values of n are 1, 5, 7, 11, 13, 17. . . . Considering next the case of a three-phaser with a star grouping of its windings, the author points out that those harmonics in the E.M.F. wave whose frequency is equal to the fundamental frequency multiplied by a multiple of 3 have no phase difference, but at any instant all act either towards or away from the neutral point, balancing each other. Hence it is that these co-phasal harmonics do not appear in the external circuit. If E_i stand for the r.m.s. value of the co-phasal harmonics in the E.M.F. wave of a single phase and E_p for the r.m.s. value of all the harmonics in that phase, then the effective r.m.s. value of the E.M.F. between two generator terminals is $\sqrt{3(E_p^2 - E_i^2)}$, which may in many cases be considerably below the commonly used value $E_p\sqrt{3}$. With a Δ connection of the windings, the co-phasal harmonics, although balancing each other so far as the external circuit is concerned, no longer do so as regards the armature, and give rise to local armature currents which increase the heat loss in the generator. These theoretical deductions are fully borne out by the results of a number of experiments carried out by the author, a brief account of which is given in the paper. A. H.

ELECTRICITY WORKS AND TRACTION SYSTEMS.

1580. *York Corporation Electricity Works.* (Elect. Rev. 46. pp. 619–622, April 13, 1900.)—*System:* Low tension direct current, three wire, with-accumulators. The boiler-room contains two 28-feet by 8-feet Lancashire boilers; working pressure, 125 lbs. The feed-water is heated by a 192-tube Green Economiser. There is a jet condenser to condense 25,000 lbs. steam per hour with a 26-inch vacuum. The engine-room contains two 3-crank GGGS and two 2-crank EE William engines driving directly 75-kw. 460 volt to 560 volt, and 24-kw. 230 volt Crompton continuous-current generators respectively. The former are suitable for lighting and traction and the latter are balancers. There are two motor-driven boosters for battery charging. Two armoured lead-covered concentric Callender feeders of 0·42 square inch section are laid directly in the ground. Distributors of similar make having a cross-section of 0·12, 0·06, and 0·12 square inch and 7/16 S.W.G. single arc cables are laid directly in the ground. The station is equipped with a 125-cell battery of Tudor accumulators in glass boxes having 250 ampere-hours capacity. The equivalent of over 7,000 8-c.p. lamps are connected and 3,000 more are being wired. Immediate extensions are contemplated. The price charged is 7d. for the first hour and 3d. afterwards up to 5,000 units per annum; 7d. and 2½d. from 5,000 to 10,000; 7d. and 2d. from 10,000 to 15,000; 7d. and 1½d. exceeding 15,000; 3d. for power and 3½d. for church lighting. There are photographic illustrations of some of the plant. J. T. R.

1581. *Greenock Electricity Supply Works.* (Electrician, 44. pp. 888–893, April 13, 1900.)—*System:* Continuous current three wire. The *boiler-room* contains two Babcock and Wilcox boilers, each having 1,827 square feet heating surface, and evaporating 7,000 lbs. water per hour, working at 200 lbs. per square inch. The boilers are fitted with B. and W. chain grates and superheaters. The feed-water is heated by a Berryman exhaust steam heater, and a 256-tube economiser. The coal is fired by mechanical stokers. The *engine-room* contains two Bellis 3-crank engines, each driving a 180-kw. Silvertown dynamo giving 300 amperes and 500 to 600 volts at 420 r.p.m. A balancer, consisting of two Silvertown dynamos each giving 200 amperes and 300 volts at 450 r.p.m., is driven direct by a Bellis engine. There are two motor-driven boosters, each giving 150 amperes at 50 to 150 volts, which may also be used as a booster balancer. Feeders of Callender's make are laid on the solid and, in some cases, the Callender-Webber systems. Three are two-wire, ½ square inch area; one three-wire, 0·4, 0·2, and 0·4 square inch, and one 0·5, 0·2, and 0·5 square inch. Single 7/16 vulcanised bitumen lead-covered arc lighting cables are drawn into Callender-Webber casing or iron pipes. The station is equipped with a Tudor battery of 304 cells giving 800 ampere hours. There are 44 arc lamps run 11 in series off the 500-volt supply. The lamp-posts are constructed to carry trolley wires. *Drawings:* Scale drawings of generating sets and photos of the plant. J. T. R.

1582. *Electrical Transmission at Grosvenor Dale Cotton Mills.* (Amer. Electn. 12. p. 123, March, 1900.)—The Grosvenor Dale Cotton Mills consist of three large buildings, each of which is situated near a separate fall along the stream. The upper fall is of about 1,100 H.P., the next about 300 H.P., and the lower one about 450 H.P. The central mill, being too small to be operated with profit, was dismantled and the power of the fall utilised for operating an electrical plant to provide lighting and auxiliary power for the other two mills.

Two 150 k.w., Westinghouse, two-phase generators, delivering current at 2,200 volts, are installed. At the lower mill this pressure is transformed down, and 1,000 16-c.p. lamps are supplied. At the upper mill are four transformers which reduce the pressure to supply 2,200 16-c.p. lamps and several small Westinghouse induction motors operating at 200 volts. At this mill are two 100-H.P. Westinghouse two-phase motors taking current at 2,000 volts direct from the main generators. These motors are belted direct to the main shaft. The electrical equipment was guaranteed to operate successfully under a maximum variation of 3 per cent. of the steam-engine speed at the mill, and 5 per cent. of the water-wheel speed at the generating station. The results are satisfactory, the motors having often worked at from 30 per cent. to 40 per cent. overload. A double purpose is served by the two 100-H.P. motors. It was customary at first to throw off the motors when the lighting was put on the circuit, the water power available not being quite sufficient for both. But as the motors are connected to the shafting, they are held up to their normal speed by the steam-engine and automatically reverse their action, becoming generators and helping the main generators.

This feature affords a perfect automatic regulation, and enables the full power of the water-wheels to be utilised. The distance from the works to the upper mill is 6,000 feet, and to the lower mill is 1,800 feet. E. D. P.

1583. *Tonawanda Power Company.* (Amer. Electn. 12. pp. 155–162, April, 1900.)—At Tonawanda, ten miles from Buffalo and fourteen miles from Niagara Falls, the transmission line from the Falls Company to Buffalo, is tapped, and power from it is transformed, converted, and regenerated into the various kinds of voltages and current desired for traction, arc, and incandescent lighting and distribution to motors. The plant is principally Westinghouse.

The branch transmission to Lockport is also dealt with in this station, an instrument designed by P. M. Lincoln measuring directly the factor of the load curves on which the charges are based. This factor is the aggregate length of time per month during which the load drawn is greater than that contracted for. The instrument, which might be termed an overload-time meter, consists of a recording train measuring hours, driven by clockwork, the motion of which is stopped whenever the load is less than the normal amount which the circuit is supposed to take. When there is an overload upon the line a pivoted armature is rotated by its laminated alternating-current magnet in such a way that the clock escapement is released, and the meter then commences to register.

The high-tension fuse used in this station consists of an aluminium wire about a foot long fastened to carbon clamps and stretched between the upper ends of two long wooden poles. At its lower end the shorter of these poles is hinged to the other. The wire fuses with 50 amperes, and directly it melts the hinged pole is forced outwards by a spring and then falls by gravity, giving a break of about 6 feet. By grasping the lower end of the longer pole the fuse breaker as a whole can be withdrawn from its knife contacts. The transformers are of the oil insulated self-cooling type, delta connected, each unit being rated at 500 kw. A peculiarity is that each transformer has two entirely independent secondaries, one of 4,400 volts for the distribution of 25 cycle power to outside consumers, and the other 360 volts for supplying the railway rotaries and the motors of the central station motor-generator sets. As the currents through the primary are the resultant of both loads, this arrangement allows of one service being considerably overloaded if the other is underloaded. As 11,000 volts are delivered in Buffalo, the pressure at Tonawanda rises at times considerably above this; the windings are therefore arranged to give various ratios.

The two 500-kw. rotary converters deliver 500-volt continuous current, and are compound wound and fitted with equalisers. They have magnetic oscillators, which move the shafts axially and thus prevent the brushes from wearing grooves into the commutator or collector rings. E. K. S.

1584. *Three-phase Transmission on the Union Railroad, Providence, R.I.* **B. Harding.** (Street Rly. Journ. 16. pp. 294–296, April, 1900.)—The Union Railroad Company of Providence is extending its lines into the surrounding country districts. The first of these extensions has a length of eighteen miles. The towns along the route are summer pleasure resorts built on the shore of Narragansett Bay. The power station in Providence has a total capacity of about 5,000 H.P. To supply current to the new extension line a substation has been erected at Riverview, fourteen miles from Providence. At this substation rotary converters are installed receiving polyphase currents from Providence and supplying the line with direct current. At the central station, Providence, there are two 300-kw. Westinghouse rotary converters, which receive direct current at 575 volts and deliver two phase alternate-current at 400 volts with a frequency of 60 cycles per second, when running at 600 r.p.m. These machines are guaranteed to give their normal output, 300 kw., for twenty-four hours without an increase of temperature exceeding 40° C. above surrounding atmosphere, and to carry 25 per cent. overload for ten hours, or 50 per cent. overload for two hours, or 90 per cent. overload for ten minutes, without injurious heating. These rotary converters are provided with separate shunt-wound exciters coupled to their shafts. The fields of these exciting machines are run considerably under saturation-point, so that any increase in speed of the rotary is followed by a large increase in its excitation. The object of this is to prevent the running away of the rotary, which is likely to occur if the direct-current side were simply run as a shunt to the mains, due to the considerable field-weakening effect caused by the armature reaction of lagging currents.

The two-phase currents of the converter are transformed by four 200-kw. Westinghouse self-cooling, oil-insulated transformers to three-phase 10,000 volt currents. This is transmitted by three No. 4 copper wires supported overhead by Locke triple petticoat glass insulators to the Riverview substation. Here it is transformed by four Westinghouse transformers of 150 kw. each, to two-phase 400 volts. Additional terminals are provided for alternate-current connections corresponding to direct-current voltages of 550, 565, and 580 volts respectively. The current passes from the transformers to the two rotaries, which have a capacity of 250 kw. each. The high-pressure three-phase lines are carried overhead upon the poles of the Narragansett Electric Light Company within the city, and on the trolley poles outside the city limits, the wires being arranged in an equilateral triangle 18 inches apart.

The track outside the city limits is single, with turnouts at the stations ; it is standard gauge and in good condition, having previously been used as a steam railroad. This track was formerly owned by the New York, New Haven, and Hartford Railroad Company, and was operated by steam. The fare charged from the Union station to Buttonwoods was 25 cents by the steam company ; by the electrical company the fare is 15 cents.

Some illustrations are given of the rotary converters and also some particulars of the rolling stock and the times of service. E. D. P.

1585. *Southampton Tramways.* (Electrician 44. pp. 813–816, March 30, 1900.)—A preliminary description of temporary generating plant and ultimate scheme. It is proposed to charge a large 500-volt battery from 230-volt lighting dynamos in series during light loads, and to drive the cars from the battery alone during certain hours of the day when the lighting load is heaviest.

J. T. R.

1586. *Aberdeen Tramways.* (Tram. Rly. World, 9. pp. 5–10, Jan. 1900.)—*System :* Overhead trolley, continuous current. The *boiler-room* contains four 159-H.P. and four 96-H.P. Babcock and Wilcox boilers, 150 lbs. working pressure. The *engine-room* contains nine Willans and one Bellis engines, together indicating 2,000 H.P. Three engines indicating together 1,150 H.P. are for traction. Each of the three drives directly a Mather and Platt 550-volt, six-pole, compound generator. The track is equipped on the overhead centre trolley wire system : 30 ft. 6 in. steel poles carry, by means of bow bracket arms where the poles are between the tracks, and by span wires where the poles are on the footway, 00 B and S h. d. copper trolley wires, insulated by Ohio Brass Company's insulators. The rails are of girder type, 98 lbs. per yard, tied together by 2-in. × ½-in. ties, 5 feet apart. The fishplates weigh 78 lbs. per pair, and the joints are bonded by double Neptune 6/0 wire bonds. There are cross bonds at intervals of 40 feet. The foundation of the track is concrete 6 inches deep. The roadway is paved with 7 in. × 3½ in. × 7 in. granite setts. There are eight top-seat motor cars fitted with Brill trucks, two Westinghouse motors, seating capacity 28 outside, 24 inside. *Drawings :* Scale plan of generating station, section of track, rail section, and photograph of plant and track. J. T. R.

1587. *Ghent Tramways.* **J. Buse.** (Ind. Élect. 9. pp. 96–98, March 10, 1900.)—*System :* Accumulators on cars. The *boiler-room* contains three Piedboeuf boilers with 150 square metres heating surface and 4 square metres grate surface. The feed-water is heated by a Green economiser. The *engine-room* contains three 300-I.H.P. Corliss compound engines having cylinders 50 and 80 cm. diameter, 80 r.p.m., each driving by belt a Westinghouse six-pole generator giving 800 amperes and 250 volts at 400 r.p.m. There are three panel generator-switchboards fitted for charging accumulators. Two charging boosters increase the voltage to 280. The car-charging barn contains six trucks and 90 charging benches. The rails are of the Broca type, 47 kg. per metre, 16 cm. deep, 14 cm. broad at bottom. The 29 mm. groove was too narrow on curves and had to be increased by about 7 mm. There are 52 motor cars fitted with 15 H.P. 250-volt motors, and 108–150 ampere-hour cells, weighing 3,300 kg. with acid, grouped in series or parallel by the controllers, by which the speed can be varied from two to twenty miles per hour. The acid injures the cars. The town receives 17·5 per cent. of the gross receipts. The manufacturers maintain the cells for 1·1d. per car mile. J. T. R.

1588. *Copenhagen Electricity Works.* **C. G. Hoest.** (Elektrotechn. Zeitschr. 21. pp. 368–372, May 10, 1900.)—A description of the central station for light and power erected by the city authorities of Copenhagen for supplying the suburbs as well as the city proper. Peculiar circumstances affecting this are referred to.

The system adopted is three-wire continuous current. A large storage battery is installed, the voltage for light and power being arranged at 220 volts, and that for tramways at 250 volts. The division of the voltage of the generator is effected by means of the accumulator. The buildings are designed for an extension to three times the demand for which provision is now made. At present the H.P. is 4,400, of which 570 can be supplied by the accumulator. The accumulators are of the Tudor type, with a maximum discharge rate of 1,908 amperes for three hours. A somewhat special arrangement for working the regulating switches in the end cells in both charge and discharge is described, and a diagram given of the switchboard connections.

Babcock and Wilcox boilers are used, and are fitted with induced steam draught on Granger's system for burning small coal. The feed-water is taken from the mains of the Copenhagen Water Company, and is first put through a cleanser in which a mixture of lime and soda causes a deposition of deleterious matter without heating. Large reservoirs are provided for the cleansed water from which the feed-pumps take the supply. E. C. S.

1589. *Perth* (*W.A.*) *Electric Tramways.* (Street Rly. Journ. 16. pp. 288–293, April, 1900.)—*System:* Overhead trolley. The boiler-room contains Babcock and Wilcox boilers, working at 160 lbs. pressure. Water is obtained from an artesian well which has a capacity of 375,000 gallons per day. The engines are tandem, compound, of 300 H.P. each, built by the Robb Engineering Company, Nova Scotia. They are direct coupled to General Electric generators, yielding 550 volts at 150 r.p.m. The plant is run non-condensing at present, but arrangements are made for installing condensers in the future.

The overhead line work consists of wrought-iron tubular poles of 4 in., 5 in., and 6 in. sections, set in the ground to a depth of 6 feet, and embedded in concrete. They are fitted with a malleable iron four-pin cross-arm. Cup and cone hangers, 15 in. ears, wooden span-wire insulators, No. 00 trolley wires, and No. 000 feeders are used throughout the work. Great difficulties were experienced in the erection of the overhead work, chiefly due to the large number of electric light, telegraph, and telephone wires over the streets. At one street-crossing no less than 750 wires were found, the lowest of these being only 15 feet above the head of the rail. In some cases, some of these wires were cabled, but the greater part of the work necessitated the setting of higher poles and the raising of the cables and wires.

The rails used are 9-inch, 84-lb. grooved girder, 30-feet lengths; the joint-plates are 36 inches long, fastened with twelve 1-in. bolts. They are laid on jarrah ties, 6 in. × 8 in. × 6 ft. 6 in., placed 2 feet between centres. A 3 ft. 6 in. gauge, the standard of the Western Australian Government railways, is adopted, and was specified in the concession. Tie rods are used 6 feet apart. The rails are bonded with two No. 0000 flexible horseshoe bonds, and the track is cross-bonded every 120 feet. Wood paving is used, blocks of jarrah, 3 in. × 9 in. × 6 in., being laid on concrete foundation 6 inches thick. Owing to the excessive expansion of the paving during the wet season, it was found necessary to insert "mastic" joints between the blocks at fixed points. These joints consist of ribbons or sheets of asphalt and tar to take up expansion and prevent buckling.

The rolling stock consists of ten 18-feet closed cars of the centre-aisle, cross-seat pattern, seating 28 persons; and ten standard closed cars with longitudinal seats. All the cars are mounted on Brill's E21 trucks, with 4-inch axles and equipped with G.E. 58 motors.

The article includes several illustrations showing the track and generating works during construction and when completed. E. D. P.

1590. *Special Operating Problems in Brooklyn.* **R. L. Russell.** (Street Rly. Journ. 16. pp. 338-341, April, 1900. Paper read before the New York Railroad Club, Feb. 15, 1900.)—Details are given of the various central stations, of which the following are some of the leading particulars :—

Name of Station.	No. of Babcock and Wilcox boilers.	Generators.	Capacity of Coal Conveyer.	Chimney.
Fifty-second Street	16 of 250 H.P. each, or a total of 4,000 H.P.	12 of 500 kw. each 2 of 375 „ Total, 6,700 kw.	60 tons per hour	One brick stack 12 ft. in dia. 206 ft. high
East River Station	34 arranged on double deck boiler houses; total H.P. 8,500	4 of 1,500 kw. each 2 of 1,600 „ Total, 9,200 kw.	70 tons per hour	
Ringwood Power Station	8 of 250 H.P. each, or a total of 2,000 H.P.	6 of 300 kw. each Total, 1,800 kw.		Four iron stacks each 4½ ft. in dia. 100 ft. high.
Third Avenue Power Station	12 having a total rated H.P. of 5,000	8 of 500 kw. each 2 of 800 „ Total, 5,100 kw., besides two 200 kw. boosters		One brick 8½ in dia. 150 ft. high Two iron stacks 6½ ft. in dia. 125 ft. high
Thirty-ninth Street Station	10 having a total rated H.P. of 25,000	2 of 1,120 kw. each 2 of 660 „ Total, 3,560 kw., besides a 560 kw. booster		One iron stack 8½ ft. in dia. 165 ft. high

Particulars are given of how the special conditions of certain lines carrying excursion traffic were met by the use of boosters. On the Sixty-fifth Street to Coney Island line, 6·13 miles long, double track, which in the season carries as many as 105,000 passengers per day, the carrying capacity of the copper conductors was the only thing considered, the idea being to put up as little copper as possible. The cars are spaced as closely as possible, and the highest reading taken is 2,060 amperes or 1,880 H.P. To keep a uniform voltage so that a high-speed schedule can be maintained, there are specially designed boosters, direct connected to engines, which are wound to give any desired increased pressure from 25 to 400 volts above that of the power station. The method has worked with entire satisfaction, the average voltage during the heaviest hours varying from 486 to 510.

For the heavy electric elevated trains over the Brighton beach line, it is proposed to install a secondary battery to help in giving the large currents taken at starting the train. E. K. S.

1591. *Detroit, Rochester, Romeo, and Lake Orion Railway.* (Street Rly. Journ. 16. pp. 286–288, April, 1900.)—Commencing at Detroit, this railway runs for a short distance over the lines of another company; then over its own track to Rochester, 15 miles; here it divides, one branch going to Romeo, 12 miles; the other branch to Lake Orion and Oxford, 13 miles. The power station is at Rochester. The boiler house, 47 feet × 70 feet, contains at present two 250 H.P. boilers. There are two Deane feed pumps, each capable of supplying a 500 H.P. boiler with water; injectors of the Metropolitan type are also installed, and are connected to both the creek and the city water mains. The feed-water is brought from a creek, 300 feet away, through a 6-inch cast-iron pipe, in which is a Worthington strainer. The injection water for the condensers also comes from this creek in a 10-inch cast-iron pipe, and is discharged back into the creek through a 15-inch terra-cotta pipe. The engine-room, 50 ft. × 70 ft., contains two 325 H.P. tandem compound condensing Ball and Wood engines, running at 200 r.p.m. Goubert heaters are placed between the low pressure cylinders and the Deane jet condensers; the feed piping is so arranged that one or both heaters may be used, or a supplementary heater (fed by exhaust from feed and vacuum pipes); water relief valves are placed on each heater and feed pump. Crocker-Wheeler generators are used, 200 kw., 550–650 volts, and direct coupled. A booster set is also installed, consisting of a 150-ampere, 600-volt motor, mounted on the same base with a generator having a capacity of 400 amperes at 150 volts. This generator is in series with the line, and can raise the pressure of the booster feeder from 650 volts to 800 volts.

The track is laid with 56-lb. 60-feet rails on cedar ties, with oak ties at curves and special work. The joints are fastened with six-hole fishplates and protected rail bonds are used. The whole track is ballasted with gravel, of which there is a depth of 6 inches below the ties. Turnouts are 4 miles apart, with telephones at each. Double trolley wire, 00 figure 8, is used, feeders being tapped into it at every half-mile. The poles are of cedar.

The rolling stock consists of eight Kuhlman cars, 45 feet over all, weighing 21 tons, and seating capacity of fifty-four. Two 65-H.P. Westinghouse motors are on each car; the brakes used are of the Magann stored air type. Kalamazoo trolley wheels are used, and are found to run from eighty to ninety days.

The company also furnishes the city lighting for Rochester. The equipment for this consists of a 150-H.P. 550-volt motor, direct coupled to a 90-kw. Westinghouse alternator, which operates at 11,000 volts. A Chapman voltage regulator is used, and by this means the town lighting pressure is regulated to within a 2 per cent. variation. E. D. P.

1592. *Dayton* (*Ohio*) *Electric Railways.* (Street Rly. Journ. 16. pp. 277–285, April, 1900.)—The street railways of Dayton are operated by three separate and distinct companies. Each company has its own car houses, and its own shops, and all have been remarkably successful. Previous to this year there had already been built two railways of 25 miles and 84 miles in length respectively. The three new lines which started operating in January of this year are the Dayton, Springfield, and Urbana, 48 miles; the Dayton and Xenia, 33 miles; and the Dayton-Xenia Rapid Transit, 18 miles long.

Dayton, Springfield, and Urbana Electric Railway.—The line is double track in both Dayton and Springfield, but is otherwise a single line, with turnouts, and is constructed entirely on a private right-of way, varying in width from 50 feet to 300 feet.

One generating station is at Medway, the centre of the Dayton-Springfield section; the other, in course of erection, is at Bowlersville, on the Urbana section, and both are of quite similar construction and equipment. The boiler-room, 55 ft. × 48 ft. 4 in., contains three 250-H.P. Babcock-Wilcox boilers, Blake pumps, Goubert heaters, Stratton separators, and Chapman valves. The station is located on Mad River, and has an abundant water supply. The equipment of the engine-room, 99 ft. × 50 ft. 8 in., consists of three Slater cross compound condensing Corliss type engines, 450 H.P. each, 100 r.p.m., direct coupled to three 325-kw. Westinghouse generators. One 100-kw. Westinghouse booster is used.

The overhead city construction is side pole, with steel poles 28 feet long, in two sections; the lower section, 6-inch pipe, 20 feet long, the upper section, 5-inch pipe, 8 feet long with the joint 18 inches long, swedged and turned on top to shed water. Spans are attached by pole-bonds, with Creaghead strain insulators at the pole, and glass brake knobs are placed in the spans 4 feet on each side of the trolley wire. The rest of the road is equipped with Creaghead flexible brackets, 10 feet long, supported on wooden poles 7 inches diameter at the top, and of lengths sufficient to bring the top cross-arm 24 feet above the track. The poles have two four-pin cross arms, the upper one for the telephone and block signal system, and the lower one for feeders. In Dayton 95-lb. girder rail is used; in Springfield and Urbana 95-lb. girder section. All rails are in 60-feet lengths, laid on 6-in. × 8-in. × 8-ft. ties. The inter-urban sections are laid with 75-lb. rails. The joints are made with six-hole fishplates, which conceal two ·0000 Crown rail-bonds. The rails are also cross-bonded, and wherever a stream is crossed a heavy copper ground-plate is used. After the subgrade was completed and ditched a layer of 12 inches of gravel was put on; the ties were covered with the same material, thoroughly tamped. Plate girder bridges resting on stone abutments are used for crossing small streams. There are also three Pratt truss bridges on the line of 156-feet, 136-feet, and 80-feet spans. There are fourteen passenger cars, four combination passenger and baggage cars, one snow plough, and a special Pullman car for parties. Each car is equipped with four B47 G.E. motors. Ten have G.E.C. electric brakes, and the rest are fitted with Christensen air brakes.

Dayton and Xenia Traction Company's Line.—The generating station is situated near the centre of the Xenia section, on the Little Miami River, which provides an abundant water supply. The boiler house contains four 250-H.P. Cahall vertical boilers, Cochrane heaters, Buckeye separators, chain grates, Stilwell-Bierce and Smith-Vale pumps and condensers, and Metropolitan injectors. The engine-room contains two 750-H.P. cross-compound Buckeye engines, direct coupled to 500 kw. Westinghouse generators. The track is constructed of T-rail, 90-lb. on the Xenia section and 80-lb. on the Spring Valley section. In Dayton 95-lb. grooved rails and in Xenia 90-lb. girder rails are used. All rails are laid on oak ties, 6 in. × 8 in. × 8 ft., spaced 2 feet apart centre to centre, and bedded in gravel. Where the line crosses small streams oak trestles have been erected; there are also several steel bridges on the line. Side pole span construction is used in the cities and villages. The steel poles are in three sections 28 feet long, set in concrete ; on the interurban lines 30-feet poles with 7-inch tops are used.

The rolling stock consists of six passenger cars, two passenger and baggage cars, six open single truck cars, one freight car, one single truck repair car, and one snow plough. The passenger cars are equipped with Christensen brakes, and each car carries four Westinghouse 56-A motors. The road is operated by a telephone system, in connection with a block signal system.

Dayton and Xenia Rapid Transit Railway.—The power house is situated on the Little Miami River, which provides an abundant water supply. The boiler room contains four 200-H.P. horizontal water-tube boilers. The engine-room contains two 500-H.P. Lane and Bodley Corliss engines driving by belt two 400-kw. G.E. generators. Iron pole span construction is employed in Dayton; the rest of the line has wooden poles, to which are attached Creaghead flexible brackets. The track is of 70-lb. T-rails, joined by six-hole angle bars 30 inches long. The joints are bonded each with one No. 0000 Atkinson rail bond. The rails are laid on oak ties 6 in. × 8 in. × 8 ft., spaced 2 feet centres and bedded in gravel.

The article is fully illustrated, and also deals with proposed further extensions of the electric railways of Dayton. E. D. P.

1593. *The Langen Monorail Suspended Railway at Elberfeld-Barmen.* (Engineering, 69. pp. 412–413, March 30, 438–441, April 6, 501–503, April 20, 1900.)—A brief review of monorail systems and some of their advantages and defects. The Elberfeld-Barmen line is 8¼ miles long, 6·2 of which are above the River Wupper, whose width varies between 68 feet and 115 feet. A number of extensions are contemplated, but these will be electric surface trains. The sharpest curve on the track proper is 295 feet radius, but there is one close to the Vohwinhel terminus of 100 feet, and on the sidings 26 feet radius. The maximum gradient is 1 : 22. The actual speed is 31 miles per hour, which can be attained in 15 seconds. It will be possible to keep up an average speed, including stoppages, of 20·5 miles per hour. The stations are about 0·4 mile apart. The construction of the track is described and illustrated.

The trains, which consist of two carriages, but may be increased to four, are driven electrically, the supply of current to the two lines being entirely separate. A common parallel series car controller, for all motors, is in the first carriage. At both ends of each car, accessible to the guard, are levers of the hand brakes, Westinghouse automatic brake and circuit breakers. Five 4-in. pipes 56 feet long beneath the floor of the car serve as air cylinders, which are filled with compressed air at 115 lbs. per square inch at the termini.

Each car is suspended from two 2-wheel bogies. Each bogie is fitted with a 36-H.P. electric motor driving the wheels by spur gearing. The round rail-heads form the centre about which the whole carriage can oscillate. The cars, which are constructed of steel lined with wood, carry fifty passengers, and weigh fourteen tons when full. Current consumption does not appear to be greater than on surface tram cars, which do not attain half the speed. The automatic block system, which permits of a two-minute service, the signalling arrangements and the stations are described, as are other types of Langen railways. *Drawings.*—Scale plan and gradients of route, details of construction of track, plan of terminal station and siding, and scale-drawing of carriage. J. T. R.

ELECTRIC TRACTION AND AUTOMOBILISM.

1594. *Coal Consumption in Steam Power Plants for Electric Traction.* **A. della Riccia.** (Écl. Électr. 23. pp. 121–130, April 28, 1900.)—A commentary upon a paper by A. B. Herrick (see 1900, Abstract No. 974). The subdivision of losses outside the generating station is discussed in detail, and also the selection of the type of steam engine, boiler, and steam pressure with reference to *elasticity* of the plant, *i.e.*, its capacity for dealing with sudden and large increases of load, *economy* or the attainment of a high degree of efficiency under the varying conditions of load, and "promptitude," or the rapidity with which the generating plant will respond to variations of load great and small.

Calculations are given from which it appears that the mean efficiency of generating units, within the conditions of variable load assumed, increases with the H.P. of these units in a greater ratio than the maximum efficiency. The author arrives at the following interesting conclusion in connection with the use of a battery of accumulators as an equaliser. Assuming that 40 per cent. of the energy supplied by the battery to the line is lost in the battery itself and in the various apparatus for its regulation, it would appear that from the point of view of coal consumption alone, the value of an accumulator in electric tramway systems of varying sizes, but in which the proportional load variations are similar, diminishes as the power generated increases, until a point is reached (apparently at about 300 H.P. units), when the saving effected by the accumulator vanishes altogether. E. C. S.

1595. *Electric Traction under Steam Railway Conditions.* **E. C. Boynton.** (Amer. Inst. Elect. Engin., Trans. 17. pp. 1–19, Jan., 1900.)—There are three methods of using electricity as a motive power on a steam railroad. (1) By electric locomotives. (2) By standard coaches equipped as motor cars. (3) By special light motor cars and trailers and the withdrawal of standard coaches.

The first method is good where the traffic is heavy, the speed high, and service frequent, especially if the same trains run over both steam and electric lines. The cost of repairs is only about 10 per cent. of that of a steam locomotive. The second method is cheap and convenient. The motor car carries its own paying load, and can be run light when required. The cost of converting a standard coach is about $3,800 when two motors are used. The third method reduces the dead-weight hauled, which means economy of power, the cars are cheaper to construct, and the wear on the rails is less. The cost of maintenance is greater with the lighter cars.

For transmitting the power a third rail construction is cheaper to maintain and construct than a trolley line. The former can be efficiently insulated by being supported on wooden blocks dipped in some insulating compound and attached to the sleepers. Feeders are not often necessary, as there may be only two, or at most three trains running at the same time. T-rail, when used for the third rail, is very difficult to bond satisfactorily.

The power stations required on converted steam railroads do not differ from those for ordinary street railway work. They cost about $80 to $90 per kilowatt to build.

The cost of a three-car steam train kept constantly moving for about nine hours, and covering 150–200 miles is about 30 cents per mile at least. A three-car electric train, one of the cars being a motor car, can be run for 14 cents per mile, whilst doing the same work.

Steam roads which have introduced electric motive power find it cheapest and most satisfactory to supply their own current for lighting their stations and freight-houses. A simple way is to wire the lights in groups of five or six in series, and connect directly between the working conductor and the ground. A battery and rheostat can be connected in parallel with the lighting load, acting as a regulator. P. D.

1596. *Electrolysis by Earth Returns in Chicago.* **E. B. Ellicott.** (West. Electn. 26. p. 87, Feb. 10, 1900.)—Within the last two years many cities have experienced serious troubles from the bursting of water mains, and in nearly every instance the primary cause of the bursting was due to the deteriorating effect of the return current from a street railway. Some of the conditions in Chicago are especially bad, and no effort seems to be made by the companies to make such corrections as may be in their power. The situation is now such that nothing but a combined effort of all companies will clear up the dangerous conditions and relieve the companies of a liability that will surely be placed upon them by the courts.

It is the practice in street-railway work to bury under the rails a large amount of copper wire, and at points varying from 25 feet to 1,000 feet apart, to connect this wire to the rails with copper connecting wires. The importance of good bonding and connecting is illustrated by an example in Chicago, where the drop in potential in one mile of track and supplemental copper-return wire was 8½ volts. After three bad bonds had been replaced, a drop of only 2½ volts was shown. A water-pipe ran parallel to the track for a considerable distance, and, before the change in bonds, it was found to be 1 volt positive to the rails at two places. After the change in bonds the potential between the rails and water-pipes was about one-thirtieth of a volt at all points.

After a careful study for over two years, the author has recommended a clause to be inserted in an ordinance recently passed by the council, requiring the railway company to provide and maintain a return circuit of such conductivity that the *maximum potential* between any part of the return circuit and the water-pipes should not *exceed one volt*, and also providing that there should not be a *variation* in potential of more than *one-half volt* between any *two* points within a *distance of 300 feet*, measuring along the line of the railway. Under these conditions there will be some flow of current to and from the water-pipes, but with the one-half volt variation the disintegrating effect will be distributed over a large area of water-pipe. The author maintains that the only excuse for using a grounded return circuit is the question of economy in construction and maintenance. E. K. S.

1597. *Working Expenses oj Electric and Cable Railways.* (Tram. Rly. World, 9. pp. 138–139, April, 1900.)—A comparison of the financial results of the Liverpool Overhead and City and South London Electric Railways, and the Glasgow District Subway worked by cable traction.

Table I. gives particulars of the three railways relating to the last half-year, in addition to those given in Abstract No. 1287 (1899), and Table II. (which is abstracted from the particulars in the article) gives the financial results for the last six half-years.

TABLE I.

	Liverpool Overhead.	City and South London.	Glasgow Subway
Receipts per passenger carried	1·96d.	1·92d.	1·26d.
Train miles run per double-track mile ...	59,666	80,598	82,809
Passengers carried per double-track mile	772,956	1,147,647	1,059,310

TABLE II.

NAME OF LINE.	HALF-YEAR.	PER TRAIN MILE—PENCE.							TOTALS.					REMARKS.
		Maintenance of Way, Works, and Stations.	Locomotive Power.	Car Repairs and Renewals.	Traffic Expenses.	General Charges, Taxes, &c.	Total Expenses.	Receipts per Train Mile.	Per cent. of Expenses to Receipts.	Total Expenses.	Total Receipts.	Miles Run.	Passengers Carried.	
LIVERPOOL OVERHEAD ELECTRIC RAILWAY.	June, 1897	1·8	3·42	0·29	5·41	3·26	14·18	23·79	59·6	21,459	36,026	363,399	4,269,260	Time during which workmen's tickets available has been extended.
	Dec., 1897	2·16	3·71	0·38	5·12	3·44	14·81	24·25	61·07	22,940	37,559	371,773	4,467,490	
	June, 1898	1·89	3·93	0·46	5·59	2·74	14·61	24·63	59·32	22,076	37,220	362,690	4,472,941	
	Dec., 1898	2·14	3·91	0·53	5·57	2·77	14·92	26·12	57·12	23,218	40,656	373,560	4,894,921	
	June, 1899	1·8	4·31	0·46	5·79	2·74	15·1	23·32	64·75	23,624	36,492	375,500	4,475,279	
	Dec., 1899	1·29	4·17	0·27	5·4	2·58	13·71	25·42	53·93	25,007	42,662	402,752	5,214,957	
CITY AND SOUTH LONDON ELECTRIC RAILWAY.	June, 1897	0·59	6·11	0·57	6·25	2·7	16·22	29·15	55·64	15,734	28,260	232,703	3,437,810	Very keen competition with L.C.C. tramways. Cost of fuel no material effect.
	Dec., 1897	0·62	5·83	0·48	6·08	2·65	15·66	27·63	56·68	15,035	26,528	230,396	3,337,861	
	June, 1898	0·76	5·85	0·56	6·03	2·72	15·92	28·1	56·65	15,614	27,552	235,342	3,478,977	
	Dec., 1898	0·83	5·65	0·56	6·17	2·67	15·88	28·28	56·15	15,498	27,588	234,166	3,462,814	
	June, 1899	0.79	5·85	0·48	6·14	2·91	16·17	28·69	56·36	15,851	28,125	235,254	3,540,098	
	Dec., 1899	0·67	5·85	0·48	6·09	2·75	15·84	26·87	58·95	15,968	27,506	241,973	3,442,942	
GLASGOW DISTRICT SUBWAY CABLE TRACTION.	July, 1897	0·88	2·14	0·35	1·63	0·74	5·74	12·01	47·79	12,205	25,541	510,161	4,178,215	Fares very low. Route circular. Expenses per train mile much increased by higher wages and dearer coal.
	Jan., 1898	0·7	2·99	0·39	1·85	1·22	7·15	12·98	55·08	16,492	29,937	553,307	5,450,177	
	July, 1898	0·76	3·0	0.4	2·08	0·94	7·18	14·44	49·72	16,247	32,682	543,114	5,779,119	
	Jan., 1899	0·83	3·02	0·41	2·08	0·79	7·13	15·54	45·88	16,474	35,925	554,770	6,666,082	
	July, 1899	0·82	3·16	0·24	2·47	0·99	7·68	15·78	48·67	17,520	35,977	547,083	6,505,221	
	Jan., 1900	0·75	3·08	0·23	2·57	1·3	7·93	16·2	48·95	18,471	37,744	558,961	7,150,342	

The Glasgow expenses are only about a halfpenny per passenger, while those of London and Liverpool are about a penny. Glasgow runs the largest number of train miles per mile of track, but its train is the smallest. E. K. S.

1598. *Electrolysis by Earth Returns.* **A. A. Knudson.** (Amer. Electn. 12. pp. 119–120, March, 1900.)—The author is of opinion that the independent return is not the absolute cure for electrolysis which some believe it to be. He has measured a number of joints in water-mains, and generally found their resistance to be proportional to the length of time they have been in the ground; thus, in some tests on 27 joints on 4-in. and 6-in. pipes it was found that in eleven months some had doubled, some trebled in resistance, whilst others had increased as much as sixty times. Before ordinary water-pipe lengths are laid they are treated with asphalt varnish inside and out, and when laid together lead is run in. Now if in the caulking process the lead touches the iron in any place galvanic action is set up, and this, added to ordinary corrosive effects, causes the resistance of the joint to increase year by year. The effect of such resistance causes any current which may be passing along the water-pipes to leave the positive end of the pipe and pass through the earth around the joint, to the end of the next length, or the current may pass through the water in the pipe and cause electrolytic pittings inside. The author is of opinion that pipes which have been underground five years or longer should *not* be connected with street railway systems. In other words, the older the water-pipe the less able it is to carry current without damage to itself. In criticising another suggestion, viz., to use a generator of low voltage at the power station to lower the potential of the piping, the author says that any method which compels the water-pipes of a city to act as a return conductor for railroad circuits is wrong in principle to begin with, and detrimental to the piping system in the long run. If water and gas mains were continuous conductors, like lead-sheathed cables having *no* joints, then the problem would be less difficult. Seeing, however, that things are as they are, there is nothing in sight as an absolute cure for electrolysis except to abandon the earth, as the telephone companies had to do when the overhead trolley came in. This means double-overhead or underground systems, and it may be mentioned that the former has been adopted on Cincinnati and on some of the Washington lines. E. K. S.

1599. *Motors for Electric Automobiles.* **P. M. Heldt.** (Elect. World and Engineer, 35. pp. 360–361, March 10, 1900.)—Considerations of efficiency lead to the use of relatively heavier motors than have been usual for tramcars, which do not have to carry their own power storage. The motors generally weigh about 10 per cent. of the loaded vehicle. Devices for avoiding differential gear are numerous. Monnard uses a motor having two independent armatures in a single field, and thereby saves weight over any two-motor arrangement. Another device is to have a motor with armature and field both revolving in opposite directions, thus doubling the relative speed of the members, and consequently the output per lb. The drawbacks to this are extra bearings and the necessity for contact rings. Another innovation is the hub motor, in which the motor field forms part of the hub casing and turns with the wheel. The armature turns free on the vehicle axle. To the hub casing is fastened an internal gear, and to the armature spider a pinion. These two are connected by intermediate gear running on a stud which is held by an arm secured to the stationary axle. E. H. C.-H.

1600. *Electric Automobiles in Chicago.* (West. Electn. 26. pp. 143–145, March 10, 1900.)—The Illinois Electric Vehicle Transportation Company is now running 72 hackney carriages at a charge of 25 cents per mile for two-seated vehicles, with a minimum of 50 cents ; and double rates for four-seated vehicles. These charges are less than for horse cabs. The company have extensive works where the cars are housed on two floors, with an Otis lift between. When a cab returns to the station after a trip it is immediately run up to one of two loading stands, which consist of a horizontally moving plunger rod, with hooks on one end, moved back and forth by means of a hand wheel and worm gear. The battery tray in the cab is clutched by the hooks and is drawn out upon a truck which is about as high as the battery receptacle of the vehicle. The battery is then drawn away from the stand and tested for specific gravity. A voltmeter reading is also taken on each cell while the battery is discharging at a 10-ampere rate. Acid is added if required to keep the specific gravity at 1·25. After being tested, the battery is run up to an outlet along the wall to be charged. The outlet of each charging circuit consists of a wooden frame which is slipped over the battery, and which is provided with automatic contacts that throw the cells into a series arrangement. The battery of each hansom and brougham contains 48 chloride cells arranged in two equal groups and giving 100 ampere-hours discharge at a 10-hour rate. The cell-cases are of hard rubber open at top. A battery with tray weighs about 1,400 lbs., and will run about 20 miles. Complete records are being taken, but are not published. Two charging pressures are used, 113 volts and 120–125 volts. When an exhausted battery is connected to the charging terminals it is first thrown on to the low-pressure 'bus-bars in circuit with a resistance of three ohms, and takes a current of about 35 or 40 amperes. As the amperes fall, the resistance is cut out gradually ; and finally, at about 10 amperes, the circuit is thrown on to the high 'bus-bar, with the full resistance, at about 30 amperes. This resistance is cut out as before, until the current drops to about 8 or 10 amperes with no resistance, when the battery is regarded as fully charged. It usually takes four hours to fully charge an exhausted battery. Arrangements are also provided for slow charging and forming, and the company intend to put every battery on a slow charge (10-ampere rate for 20 to 24 hours) at least once every two weeks.

After midnight the batteries are removed from all carriages, partly for inspection and partly to relieve the springs. An overhead trolley-wire is being provided for shifting carriages in the depôt. E. H. C.-H.

1601. *Electric Vehicles.* **A. Delaselle.** (Locomotion Automobile, 7. pp. 342–343, May 31, 1900.)—A general description of the Kriéger and the B.G.S. cars which took part in the "Criterium" organised by "Le Velo" for electrically propelled vehicles. The Kriéger car weighed complete, with two passengers, 2,140 kg. ; the accumulators weighed 1,057 kg. Fulmen accumulators were used, 42 cells of the B27 type and 36 of the B13 type being employed ; the capacity of the former is 220 ampere hours (5-hour discharge) and of the latter is 102 ampere hours. The car completed 170 km. without recharging. The B.G.S. car weighed 2,300 kg. without passengers ; the batteries consisted of two sets of 44 cells, connected in parallel ; each cell weighed 14·4 kg. and the capacity was 320 ampere-hours. A. G. N.

ELECTRIC LAMPS AND LIGHTING.

1602. *Photometric Comparison of Illuminating Globes.* **R. B. Williamson** and **J. H. Klinck.** (Frank. Inst., Journ. 149. pp. 66–74, Jan., 1900.)—The globes were used in connection with Welsbach burners. The standard of light was also a Welsbach burner and screen. The light distributing properties of the globes is investigated, the intensity of the light emitted in the various directions being found in the usual manner by reflection from a mirror. The mantles remained quite constant and were discarded upon the first sign of breakdown. When one of the mantles gave out, both were renewed. It was found that the mantle is very sensitive to changes in the condition of the air; with the room at all close, it was impossible to obtain satisfactory results. On the other hand, too much ventilation caused dancing of the flames, but the effect of this when occurring only slightly was satisfactorily annulled by the slits in the screens. Curves of the results are given, showing in each case the results with the bare lamp and with the globe on, the same mantle being used for each pair of tests. Holophane, ground-glass, opal, and reflector globes of various shapes were tested; no ornamental or coloured globes were used. The lamps were each used with the ordinary Welsbach mica chimney over the mantle in all cases.

E. D. P.

1603. *The Combinations of Arc Lamps of Different Types.* **P. Girault.** (Ind. Élect. 9. pp. 109–111, March 25, and pp. 137–139, April 10, 1900.)—The author divides arc lamps into three principal types: (1) Constant potential lamps, (2) Constant current lamps, (3) Lamps with constant apparent resistance. He then examines what combinations of these can be used in distributions at constant current and at constant potential. In distributions at constant potential we cannot place constant current lamps in series, for if there were more than one they would divide up the difference of potential between them in any way. On the contrary, we can place in series any number of constant potential lamps or lamps having constant apparent resistance, however great the number; but in the case of lamps at constant potential, good regulation requires the insertion of a regulating resistance. Lamps having constant apparent resistance regulate well whatever the value of the regulating resistance, whether zero or finite. A constant current lamp can be joined in series with any number of—(1) Lamps of similar type, (2) Constant potential lamps, (3) Combinations of both types, even when the regulating resistance is zero.

In the second article the author discusses the imperfection of the regulation of constant potential lamps and shows that the mode of regulation produces greater variations of current in these lamps than in lamps having constant apparent resistance. The regulation of most lamps seems imperfect at the moment of lighting and the placing of a constant current lamp in a circuit comprising lamps of other types is advocated, since we then have in the circuit two modes of regulating.

The different combinations enumerated offer numerous applications: (1) The voltage of an installation under 70 volts can be easily raised in order to place two lamps in circuit in place of one—whatever the type of the original lamp; (2) If an installation of constant potential lamps and lamps of constant resistance regulates badly owing to too great fluctuations of current we can replace all the former lamps by those of the latter type, or, better, by constant current lamps; (3) It is often possible to transform an installation of two lamps at 110 into three lamps at the same potential by the insertion of a suitable constant current lamp; (4) In new installations it will often be advantageous to combine lamps of different types.

In distribution at constant potential one can employ indifferently either constant potential lamps or those having constant apparent resistance.

W. G. R.

1604. *Bardon Arc Lamp.* **Aliamet.** (Électricien, 19. pp. 321–324, May 26, 1900.)—In the upper part of this lamp there is arranged a rocking-frame, to the opposite ends of which the cores of the regulating solenoids are respectively attached. On opposite sides of the axis there are also attached pulleys, and a cord passes from one carbon-holder over one of these pulleys, then under a pulley mounted on a brake-wheel arbor, then over the other pulley on the rocking-frame and has its other end attached to the other carbon-holder. The brake-lever is pivoted at one end to the frame of the lamp, and has its other end weighted and attached by a sliding connection to one side of the rocking-frame. The core of the shunt solenoid is weighted, and is connected by a rod to a piston working in a cylinder serving as a dash-pot, a small amount of lost motion being provided in the connection between the rod and piston.

When the current is turned on, the frame is rocked so as to strike the arc, the brake-lever released so as to lock the brake-wheel by the action of its weight, and the length of the arc determined by the relative strengths of the pulls of the two solenoids on their cores. As the carbons burn away the pulls alter, the frame rocks, the brake-lever is raised so as to release the brake-wheel, and the carbons are moved towards each other by the preponderating weight of the upper carbon-holder. Fourteen hundred of these lamps are in use at the Paris Exhibition.

C. K. F.

1605. *Charging for Electrical Energy.* **W. W. Lackie.** (Inst. Elect. Engin., Journ. 29. pp. 678–689; Discussion, pp. 689–690, May, 1900.)—Dividing the total costs of production into standing and generating costs, the author apportions the former as follows, in the case of the Glasgow Corporation Electricity Department:—

	Cost per kw.			Depreciation.			
	£	s.	d.	Rate.	£	s.	d.
Land and buildings......	14	0	0	1 per cent.	0	2	9
Machinery	25	0	0	7½ ,,	1	17	6
Accumulators	2	0	0	10 ,,	0	4	0
Mains and Cables.........	44	0	0	2½ ,,	1	2	0
Meters......................	4	0	0	6 ,,	0	4	9
Instruments	0	18	0	5 ,,	0	0	11
Office Furniture	0	2	0	5 ,,	0	0	1
Total per kw.......	£90	0	0	Total......	£3	12	0

This amounts to 4 per cent. on the capital for depreciation, while interest at 3·1 per cent. and sinking fund at 1 per cent. make up the total to 8·1 per cent., or £7 5s. 9d. per kw. installed. To this is added £1 10s. 3d. for rent, rates and taxes, and management, making £8 16s. in all for the standing charges.

The generating costs are as follows (1899):—

Coal	0·54d.
Oil, &c.	0·06d.
Wages	0·26d.
Repairs	0·42d.
	1·28d. per unit.

The maximum demands of all the consumers aggregate 70 per cent. of the supply applied for, while the maximum demand on the station is 50 per cent.

of the same. Taking the former value, each consumer must pay £6 4s. per kw. per annum + generating costs. In Glasgow this may be done by paying twelve monthly instalments of 10s. 4d. per kw. + 2d. per unit, or 4d. on each of 365 units per kw. + 2d. per unit, *i.e.*, 6d. per unit for 365 hours' use of the maximum demand per annum, and 2d. per unit afterwards. Customers who agree to pay for 1,825 hours' use of the maximum demand per annum are charged a uniform rate of 2d. per unit.

A comparison with the corresponding charges in the Gas Department is given, showing that the maximum demand system is inapplicable to the latter.

The author next points out certain reductions likely to be made in the future, making a capital cost £65 per kw., and the standing charges £3 17s. per kw. instead of £6 4s. The prices might then be 3¾d. and 1¼d. per unit, or 1s. 8d. per annum per 8-c.p. lamp fixed + 1¼d. per unit supplied. If a uniform rate per unit is adopted, it must be different for different classes of consumers, according to their probable hours of use. A comparison of the charges in various towns on the maximum demand system is given, with a diagram, and the paper ends with a number of tables.

In the discussion **H. A. Mavor** pointed out that in private installations distribution costs are absent, and labour charges less than in central stations, and **E. G. Tidd** considered the depreciation rates too high. In reply, **W. W. Lackie** said that in a central station only half as much plant need be installed as would be required in an isolated installation. A. H. A.

REFERENCES.

1606. *Drop in Alternate Current Mains.* **L. Fleischmann.** (Elektrotechn. Zeitschr. 21. p. 255, March 29, 1900.)—A short paper in which the author develops analytically expressions for the drop of potential along alternating-current mains, when transmitting power to an inductive load of given power-factor. A. H.

1607. *Accumulators for Motor Cars.* **E. C. Rimington.** (Automotor Journal, 4. pp. 108–109, Dec., 1899 ; pp. 141–142, Jan., 216–218, Feb., 253–254, March, 1900.)

1608. *French Electric Tramways.* (Ind. Élect. 9. pp. 113–120, March 25, 1900.)—This article contains a table giving particulars about the various electric tramways and railways in France.

1609. *Central Electric Supply Company.* (Elect. Engin. 25. pp. 559–561, April 20, 1900.)—An abstract of the specification prepared by Kennedy for work in connection with the above Company.

1610. *Overhead Line Construction.* **A. B. Herrick.** (Street Rly. Journ. 16. pp. 235–236, March, 1900.) [See also Abstract No. 786 (1900).]

1611. *Construction of Overhead Equipments.* (Elect. Rev. 46. pp. 303–304, Feb. 23, 341–342, March 2, 430–431, March 16, and 598–599, April 6, 1900.)—A series of articles dealing with the various details from the practical point of view.

1612. *Zurich Electric Tramways.* **J. S. Edström.** (Elektrotechn. Zeitschr. 21. pp. 323–328, April 26, 1900.)—A detailed description of the Zurich tramways. Eleven illustrations are given of the generating plant, various forms of rail bonds, feeder boxes, the cars, and controller arrangements, &c. E. K. S.

1613. *American Types of Automobiles.* (Elect. World and Engineer, 35. pp. 427–430, March 24, 1900.)—Detailed account of Riker motor cars. [See also Abstract No. 1220 (1900).]

TELEGRAPHY AND TELEPHONY.

1614. *Wireless Telegraph Experiments.* **Tissot.** (Soc. Franç. Phys., Bull. 141. p. 2. Jan. 5, 1900.)—With Ducretet's apparatus the author communicated over a distance of 42 km. Good results were obtained with a simple oscillator. The earth connection is imperative, but a capacity at the top of a tall wire is useless. There is no simple law between the height of the wire and the distance. Atmospheric effects are avoided by earthing the tall wire through an inductive coil and placing a capacity between the wire and coherer. M. O'G.

1615. *Wireless Telegraphy.* **R. A. Fessenden** and others. (Amer. Inst. Elect. Engin., Trans. 16. Discussion, pp. 635–678, 1899.)—This was a desultory discussion covering generally the ground that had been already traversed in the development of wireless telegraphy. New results were confined to the communication of **Fessenden,** who described apparatus he had devised to give *proportional* indications of electric oscillations at a distance. The ordinary coherer either acts or does not act—it is not a quantitative indicator. Three forms of instrument are described by Fessenden. The simplest consists of two coils connected in series with the receiving wire and with one another. Between them is suspended a closed ring carrying a mirror and suspended by a quartz fibre. An alternating field is set up in the coils on the reception of an impulse, and the closed ring is repelled, the mirror reflecting a beam of light. The deflections of the beam are proportional to the strength of the impulses emitted by the sender. This worked satisfactorily up to a distance of five miles. The second form of the apparatus is a modification of this arrangement in combination with a telephone receiver and transmitter. The third form is a coil in series with the collecting wire; through this runs an iron wire with its ends brought close together to form an air-gap in a magnetic field; a bent, closed ring supported like that used in the first-mentioned apparatus is deflected by the alternating magnetic field so formed when an impulse is received.

The rest of the discussion dealt with *proposals.* R. N. L.

1616. *Wireless Telegraphy Station at Wimereux.* **G. Ferrié** and **J. Boulanger.** (Écl. Électr. 22. pp. 507–515, March 31, 1900; Revue du Génie Militaire, t. xviii. pp. 230 and 437, 1899.)—A good general and scientific description of the above station, and up to date. The points of special interest are connected with the various methods from time to time adopted by Marconi for attempting to secure syntony between two stations. The first of these consists in varying the capacity of the aerial conductor by suspending two earthed metallic bands attached to the spar from which the former is suspended at a point slightly behind its point of suspension. The capacity is diminished or increased by approaching or withdrawing these metallic bands from the vertical conductor. By giving two distant vertical conductors in this way the same capacity, a certain amount of syntony is produced between them. Another method (described in a note) consists in connecting the vertical (or aerial) conductor to earth through the primary of an induction coil. The coherer is arranged in the secondary circuit in series with a condenser. It is suggested that the capacity and self-induction thus obtained enable syntonisation to be effected by varying their values. Another rôle played by this arrangement is that of an automatic discharger for the atmospheric electricity collected by the aerial conductor which escapes through the primary of the induction coil. A third method used in conjunction with the metallic bands above described is to vary the self-induction of the aerial conductor by rolling up some of the lower end of it (which is of course insulated) on 4 mm. ebonite cylinders. The actual apparatus used by Marconi, if differing from these methods, is not known, as he has it fixed up inside a sealed box and calls it a "jigger." An interesting fact in connection with the syntonisation experiments is that two stations, although desyntonised with one another, must not be closer together than 2,500 metres or they will interfere with one another. R. N. L.

1617. *Magnetised Coherer.* **C. Tissot.** (Comptes Rendus, 130. pp. 902–903, April 2, 1900.)—In the course of some experiments in wireless telegraphy made between Brest and Ushant, the author hit upon a device which considerably increases the sensitiveness of the steel or nickel coherer used, and at the same time makes it work with greater regularity and certainty. The device consists in placing the coherer in a magnetic field, whose lines of force are parallel to the axis of the tube. The latter should contain some kind of magnetic filings—steel, nickel, or cobalt. The electrodes should preferably be non-magnetic. The tube is placed between the pole-pieces of an electromagnet feebly excited, and the current transversing the coherer should also be feeble, so as not to interfere with the decohering action. The magnetisation of the coherer allows of the distance between the electrodes being increased five or six times. The sensitiveness is easily regulated by changing the strength of the magnetic field. When the field is suddenly annulled, the slightest shock suffices to decohere the instrument. The author, therefore, hopes to work the magnet by a relay, and thus to secure automatic decoherence. E. E. F.

1618. *Telegraph Steamer, "Von Podbielski."* **Jamieson.** (Elect. Rev. 46. pp. 728–729, May 4; 771–772, May 11, and 863–864, May 25, 1900.) —The author describes the general arrangements, engines, boilers, cabling machinery, tanks, and testing-room of a new steamer for a German firm of Cologne. The forward cable-drums have the brakes on the outside peripheries, being themselves internally geared. The brake screws are worked by means of worm gearing for fine adjustment. Johnson and Phillips have fitted the brakes with adjusting nuts, which enables them (after being regulated for any desired tension) to be released as often as may be necessary, and reapplied without the possibility of increasing the tension beyond the desired amount. The brake blocks are made of selected elm-wood, securely attached to steel straps. Each brake band has a water service pipe fixed to its periphery, with nozzles at intervals to distribute the water around the drum during working. The bands are suspended on springs, so that when released they will leave the drums equally and simultaneously all round. The springs are adjustable, so as to allow for a reasonable wear of the wooden blocks. The brake pulleys of the after paying-out machines run in water-tanks, to keep them cool. The bands are similar to those of the forward machines, but they are fitted with weighted levers, which is the general practice. Instead, however, of the weights being made always to act at the same leverage, and the brake power altered by adding or deducting weights, the positions of the weights are adjustable along the brake levers by means of a hand wheel and screw, so that the tension on the cable may be varied through a considerable range without adding or deducting any weights. The two brakes can be released bodily by means of a hand wheel and worm gear, and they can also be adjusted, so that both act simultaneously or otherwise.

The dynamometer of Johnson and Phillips consists of a sheave with a carrier sliding on a central cylindrical tubular column: this column acts as a dash-pot by having a piston working inside thereof in oil or soapy water. In addition there is a spring placed inside the column which comes into action during the lighter tensions on the cable, so that as the spring is compressed the moving weight is correspondingly lessened. This enables a greater scale range throughout the lower stresses, and the corresponding scale readings are, therefore, not directly determined by the usual dynamometer formula, but by actual trial. E. O. W.

1619. *Selective Signal and Privacy Switch for Party-Line Telephones.* **H. S. Webb.** (Amer. Electn. 12. pp. 139–141, March, 1900.)—The author describes a method by Barrett whereby six subscribers may be connected on the same pair of wires and the ground circuit as before. Means are provided for preventing cutting-in and overhearing. The six subscribers comprise three groups of two each, two stations in each group being similar but called up by currents of opposite polarity. There are eight keys in the exchange, the first six for selectively calling any one of the six subscribers, the seventh for restoring the connection of the receivers at all six stations on the line, and the eighth for disconnecting or barring all telephone receivers from the line. Supposing the two lines to be denominated A and B, a positive current from the Exchange, returning through earth, will ring up station 1, the other being unaffected; a negative current in the same circuit will ring up station 2; similarly positive and negative currents through line B and to earth, will ring up stations 3 and 4 respectively; finally a positive current through A returning through B or *vice versâ* will ring up stations 5 and 6 respectively. At the exchange the first step in calling is to depress the eighth key and send negative currents over A and B to earth at every station by which all the receivers are, by the peculiar winding of electromagnets and arrangements of armatures, locked out, and "engaged" annunicators displayed. Then the operator rings the desired station by depressing the appropriate key. When conversation is finished the seventh key is operated at the exchange, sending a positive current over both lines to earth at all stations, thereby connecting again all the receivers to the line, and again concealing the "engaged" annunicators. To call up the central exchange the subscriber merely takes down his receiver. In doing so the hook switch momentarily connects line A to earth, which affects a differentially wound annunicator at the exchange. The connections and windings are fully illustrated in the article. E. O. W.

REFERENCE.

1620. *Type-printing Instruments.* **Raps.** (Elektrotechn. Zeitschr. 21. pp. 296–300, April 12, 1900.)